

Section M

Engine, Ignition System

- 1.1 Engine Description
- 1.3 Technical Data
- 1.6 Testing Engine
- 2.1 Removing, Installing Engine
- 2.2 Disassembling, Assembling Sequence
- 3.1 Ignition System Description
- 3.2 Distributor Repair
- 4.1 Cooling System Parts
- 4.2 Heater Boxes
- 4.3 Cooling System Adjustment
- 5.1 Lubrication System
- 6.1 Cylinder Head Rebuilding
- 6.2 Piston and Cylinders
- 7.1 Disassembling, Assembling Crankcase
- 7.3 Crank and Rods
- 8.1 Clutch
- 8.3 Throwout Bearing Adjuster
- 9.1 Special Instructions

VW engines are air-cooled, four-cylinder, four-stroke carburetor or fuel injection engines with two pairs of horizontally opposed cylinders and overhead valves. They are attached to the transmission case with four bolts. The engine/transmission unit is fitted at the rear of the vehicle.

Ignition system

The ignition system has a coil and a distributor with automatic spark advance. The low tension current from the battery is converted to high tension current by the ignition system and fed to each of the four plugs in the correct sequence and exactly at the proper time by the distributor. The distributor is driven from the crankshaft by a gear and a short shaft.

Cooling

The engine is cooled by a radial fan. The fan draws air in through an opening in the fan housing and forces it past the heavily finned cylinders and cylinder heads. The air flow is directed by deflector plates fitted round the cylinders and cylinder heads. Part of the fresh cooling air is used for the heating system and is warmed by the exhaust pipes in the heat exchangers.

A thermostat controls the quantity of cooling air by means of two flaps fitted in front of the intakes to the cylinder ducts so that the engine warms up quickly and the temperature remains fairly uniform under all operating conditions. The quantity of air for the heating system is not affected by the flaps.

Lubrication system

The engine is lubricated by a pressure feed system with an oil cooler in the circuit.

The gear type oil pump is driven by the camshaft and is situated in the crankcase at the gear end of the camshaft. The oil is drawn from the lowest point in the crankcase and forced through the cooler into oil passages. Part of the oil goes through the crankshaft main bearings into drillings in the crankshaft and lubricates the connecting rod bearings. A second part lubricates the camshaft bearings and a third part passes through the hollow push rods to the rocker arms to lubricate these bearings and the valve stems. Cylinder walls, pistons and piston pins are splash lubricated.

Impurities in the oil are retained by a strainer fitted at the lowest part of the crankcase.

The oil temperature is reduced in the oil cooler by means of air supplied by the fan. The cooler is fitted in the oil circuit so that the oil from the pump must pass through the cooler before reaching the various bearings. The oil is then cooled so that it retains its full lubricating properties even at high outside temperatures and high engine speeds.

When the oil is cold and thick, an oil pressure relief valve opens and permits part of the oil to flow directly into the engine without passing through the cooler.

In the pressure circuit between oil pump and cooler there is a switch for the oil pressure warning lamp. This switch opens at a pressure of between 2.1 and 6.3 psi (0.15—0.45 kg/cm²) and breaks the circuit to the oil pressure warning lamp.

The lamp lights when the ignition is switched on and when the oil pressure is too low.

Cylinder heads

Each pair of cylinders has a detachable, finned cylinder head of cast light alloy with shrunk-in valve seat inserts and valve guides.

Valve gear

The camshaft runs in three bearings with split steel, white-metal coated shells and is driven from the crankshaft by helically toothed gears. No. 3 bearing takes the camshaft thrust. The camshaft gear is of light metal alloy and is riveted to the camshaft. The valves are operated via cam followers, push rods and rocker arms. Each cam operates the valves of two opposed cylinders in turn.

Cylinders

The four cylinders are all identical and can be replaced separately complete with pistons. The cylinders have fins to improve transfer of heat to the cooling air.

Pistons

The light alloy pistons with steel inserts are fitted with two compression rings and one oil scraper ring. The piston pins are fully floating in the piston bores and are secured laterally by circlips.

Crankcase

The split crankcase is a pressure die casting of light alloy. Both halves are machined together and must, therefore, only be replaced as a pair.

Crankshaft

The crankshaft is forged in one plane and all bearing journals are induction hardened. The crankshaft runs in four bearings in the crankcase. Bearings 1, 3 and 4 are aluminium bushes with lead-coated surfaces. No. 2 bearing — seen from the clutch end — is a split shell three-layer type. No. 1 bearing takes up the crankshaft end thrust. The flywheel is provided with a toothed ring for the starter drive and is held to the crankshaft by four dowels and a gland nut.

Connecting rods

The four I-section connecting rods are forged in steel. At the crankshaft end they have three-layer bearing shells and at the piston pin end they are fitted with steel bushes with a lead-bronze coating.

Clutch

Between engine and manual transmission is a dry, single-plate clutch which is fitted in the flywheel. The driven plate with linings on both sides is free to slide axially on the splined transmission drive shaft. The clutch cover, the pressure plate and the springs are bolted concentrically to the flywheel face. When engaged, the driven plate is pressed against the clutch surface on the flywheel by the pressure of the springs. Power can then be transmitted from engine to transmission.

Engine (assembly) **M** Type 1

Type	1/1600	1/1600	1/1600 ¹⁾	1/Model 181
Engine code letter	B	AE	AE, AK, AH ²⁾	AM
Bore mm (in.)	85.5 (3.96)	85.5 (3.96)	85.5 (3.96)	85.5 (3.36)
Stroke mm (in.)	69.0 (2.72)	69.0 (2.72)	69.0 (2.72)	69.0 (2.72)
Capacity cm ³ (cu. ins.)	1584 (96.6)	1584 (96.6)	1584 (96.6)	1584 (96.6)
Compression ratio	7.5	7.5	7.3	7.3
Output DIN PS at rpm	47/4000	50/4000	48/4000	48/4000
SAE bhp at rpm	57/4400	60/4400	46/4000 ³⁾	46/4000 ³⁾
Torque DIN mkg at rpm	10.6/2200	10.8/2800	10.2/2000	10.2/2000
SAE ft lb at rpm	81.7/3000	81.7/3000	72.0/2000 ³⁾	72.0/2000 ³⁾
Piston speed				
meter per sec. at rpm	9.2/4000	9.2/4000	9.2/4000	9.2/4000
feet per min. at rpm	1811/4000	1811/4000	1811/4000	1811/4000
Octane requirement RON	90	91	91	91
Dry weight kg (lbs.)	115 (253)	120 (265)	120 (265)	
Ignition	Battery			
Coil	12 volt			
Distributor	see M 3.2/1-1			
Ignition timing	see M 3.2/1-1			
Firing order	1-4-3-2			
Dwell angle	44-50°			
Spark plugs	see M 3.2/1-1			
Spark plug thread	M 14×1.25×12.7			
Spark plug gap mm (in.)	0.6 (0.024)			
Cooling	Air cooling by radial fan on generator shaft			
Air quantity liter (cu. ft.)/sec.	575 (21)	620 (24)		
at rpm	/4000	/4000		
Lubrication	Pressure feed by gear type pump			
Engine oil cooling	Oil cooler in fan air stream			
Engine oil filter	—			
Engine oil pressure indicator	By warning lamp			
Engine oil, changing quantity	2.5 liter (5.3 US pints)			
Engine oil, initial filling	2.0 liter (4.25 US pints)			
Oil consumption liter/1000 km	0.5-1.0			
US pints/1000 miles	1.7-3.4			

¹⁾ from engine No.: AE 558 001

²⁾ M 27 (engines with exhaust recirculation system / Automatic Stick Shift for California only)

³⁾ SAE net ratings

Type	1/1600 1/Model 181
Engine code letter	B, AE, AH, AK, AM
Cylinder heads	One for each pair of cylinders with cooling ribs
Valve seat inserts	Shrunk-in, sintered steel
Valve guides	Shrunk-in, special brass
Spark plug threads	Cut in cylinder head
Valve mechanism	Camshaft below crankshaft, cam followers in crankcase, push rods and rocker arms
Valve timing with 1 mm (0.04 in.) valve clearance	
Intake opens before TDC	7° 30'
Intake closes after BDC	37°
Exhaust opens before BDC	44° 30'
Exhaust closes after TDC	4°
Valves	1 intake, 1 exhaust per cylinder
Valve head exhaust	32.0 mm (1.260 in.) diameter
Valve head intake	35.5 mm (1.397 in.) diameter
Clearance: intake	0.15 mm (0.006 in.)
exhaust	0.15 mm (0.006 in.)
Valve springs	1 spring per valve
Cylinders	Separate cylinders of special gray cast iron with cooling ribs
Distance between centers	112 mm (4.41 in.)
Pistons	Light alloy with steel inserts
Piston pins	Floating, secured by circlips
Piston rings	2 compression 1 oil scraper
Crankcase	Two-part magnesium alloy, divided vertically through crankshaft and camshaft bearings
Camshaft	Gray cast iron, three bearings
Camshaft bearings	Thin-wall steel shells with white metal layer
Camshaft drive	Helical gears
Crankshaft	Forged high quality steel, four main bearing journals
Main bearings, 1, 3 and 4	Aluminum, lead coated
Main bearing, 2 (center bearing)	Split shells, three-layer
Main bearing journal 1-3	55.0 mm (2.165 in.) diameter
Main bearing journal 4	40.0 mm (1.575 in.) diameter
Connecting rod journals	55.0 mm (2.165 in.) diameter
Flywheel	Forged, with integral starter ring
Connecting rods	Forged, with I-section shaft
Connecting rod bearings	Three-layer, thin-wall shells
Piston pin bearings	Pressed-in steel bushings with lead-bronze layer
Clutch	
Type	Single disc, dry
Total lining area	363 cm ² (56 sq. in.) ¹⁾ 357.5—392.5 kg (786—863 lb.) ¹⁾
Pressure	

¹⁾ from August 1972 diaphragm spring clutch total lining area: 339 cm² (53 sq. in.)
pressure: 380—440 kg (838—970 lb.)

Type	1/1600 1/Model 181	
	New part	Wear limit *)
Cooling		
Thermostat opening temperature	65–70° C (149–158° F)	—
Fan pulley / crankshaft pulley out of balance	—	—
Fan out of balance	max. 5 cmg	—
Belt pulley radial runout	—	—
Engine lubrication system		
1 - Oil pressure (only for SAE 30 oil) at an oil temperature of 70° C (158° F) and 2500 rpm ... pressure	3 kg/cm ² (42 psi)	2 kg/cm ² (28 psi)
2 - Oil pressure relief valve spring (up to July 1969) Length loaded Load	43.2 mm (1.700 in.) 2.5–4.2 kg (5–9 lbs.)	— —
3 - Oil pressure relief valve spring (from August 1969) Length loaded Load	44.1 mm (1.736 in.) 5.6–7.3 kg (12–16 lbs.)	— —
4 - Oil pressure regulating valve spring Length loaded Load	20.2 mm (0.795 in.) 2.9–3.6 kg (6–8 lbs.)	— —
5 - Oil pump: Gears/housing without gasket end play Gears backlash	— 0.0–0.2 mm (0.0–0.008 in.)	0.1 mm (0.004 in.) —
6 - Oil pressure switch opens at pressure	0.15–0.45 kg/cm ² (2–6 psi)	—
Cylinder head and valves		
1 - Cylinder seating depth in cylinder head	13.45–13.55 mm 0.5295–0.5334 in.)	—
2 - Combustion chamber capacity	48–50 cm ³ ¹⁾ (2.9–3.0 cu. in.) ¹⁾	—
3 - Rocker arm inside diameter	18.00–18.02 mm (0.7086–0.7094 in.)	18.04 mm (0.7102 in.)
4 - Rocker shaft diameter	17.97–17.98 mm (0.7074–0.7078 in.)	17.95 mm (0.7066 in.)
5 - Rocker shaft/arm radial play	0.02–0.05 mm (0.0008–0.002 in.)	—

*) The term "Wear limit" means that parts which are near, or have reached the dimensions given should not be reinstalled during repairs.

¹⁾ from August 1970: 50–52 cm³ (3.0–3.2 cu. in.).

Type	1/1600 1/Model 181	
	New part	Wear limit
6 - Valve seat:		
Intake width	1.4–2.5 mm (0.055–0.098 in.)	—
Exhaust width	1.4–2.5 mm (0.055–0.098 in.)	—
Intake seat angle	45°	—
Exhaust seat angle	45°	—
Outer correction angle ..	15°	—
Inner correction angle ..	75°	—
7 - Valve guides:		
Intake inside diameter	8.00–8.02 mm (0.315–0.316 in.)	8.06 mm (0.317 in.)
Exhaust inside diameter	8.00–8.02 mm (0.315–0.316 in.)	8.06 mm (0.317 in.)
8 - Valve stems:		
Intake diameter	7.94–7.95 mm (0.3126–0.3129 in.)	7.90 mm (0.3110 in.)
Exhaust diameter	7.91–7.92 mm ¹⁾ (0.3114–0.3118 in.) ¹⁾	7.87 mm (0.3098 in.)
..... out of round	max. 0.01 mm (0.0004 in.)	—
9 - Valve guide/valve stem:		
Intake rock	0.21–0.23 mm (0.008–0.009 in.)	0.8 mm (0.032 in.)
Exhaust rock	0.23–0.27 mm (0.009–0.010 in.)	0.8 mm (0.032 in.)
10 - Valve spring:		
Length loaded	31.0 mm (1.22 in.)	—
Load	53.2–61.2 kg (117–135 lbs.)	—
11 - Compression		
(with engine warm, thrott- le open, all plugs out, gauge in plug seat and engine turned by starter)		
with code letter B, AE ²⁾	8–10 kg/cm ² (114–142 psi)	7 kg/cm ² (100 psi)
with code letter AE, AH, AK, AM	7.5–9.5 kg/cm ² (107–135 psi)	6 kg/cm ² (85 psi)
Difference between cylinders	—	max. 2 kg/cm ² (28 psi)
Cylinders and Pistons		
1 - Cylinder out of round	max. 0.01 mm (0.0004 in.)	—
2 - Cylinder/piston clearance	0.04–0.06 mm (0.0016–0.0024 in.)	0.20 mm (0.008 in.)

¹⁾ from August 1970: 7.92–7.94 mm (0.3118–0.3126 in.)

²⁾ up to engine No. AE 558 000

Type	1/1600 1/Model 181	
	New part	Wear limit
3 - Piston weight		
- Weight (brown)		
engine code letter B, AE, AM	402-412 g	
(engine code letter AE		
from Aug. 1970 up to July 1971)	398-410 g	
+ Weight (grey)		
engine code letter B, AE, AM	410-420 g	
(engine code letter AE		
from Aug. 1970 up to July 1971)	406-418 g	
4 - Weight difference		
between pistons in one		
engine	max. 5 g	—
during repair	max. 10 g	—
5 - Compression ring		
upper side clearance	0.07-0.10 mm	0.12 mm
	(0.0028-0.004 in.)	(0.0047 in.)
lower side clearance	0.05-0.07 mm	0.10 mm
	(0.002-0.0028 in.)	(0.004 in.)
6 - Oil scraper ring side clearance	0.03-0.05 mm	0.10 mm
	(0.0011-0.0019 in.)	(0.004 in.)
7 - Compression ring		
upper gap	0.30-0.45 mm	0.90 mm
	(0.012-0.018 in.)	(0.035 in.)
lower gap	0.30-0.45 mm	0.90 mm
	(0.012-0.018 in.)	(0.035 in.)
8 - Oil scraper ring gap	0.25-0.40 mm	0.95 mm
	(0.010-0.016 in.)	(0.037 in.)
Connecting rods		
1 - Connecting rod weight, in production	500-610 g	—
supplied as spare part		—
- weight (brown or white)	580-588 g	—
+ weight (gray or black) ..	592-600 g	—
2 - Weight difference between connecting rods		
in one engine	max. 5 g	max. 10 g
3 - Connecting rod bushing . diameter	22.008-22.017 mm	—
	(0.8664-0.8667 in.)	
4 - Piston pins diameter	21.996-22.000 mm	—
	(0.8658-0.8661 in.)	
5 - Piston pin/bushing radial play	0.01-0.02 mm	0.04 mm
	(0.0004-0.0008 in.)	(0.0016 in.)
Crankcase bores		
1 - Bores for crankshaft bearings	65.00-65.02 mm	65.3 mm
a) Bearing Nos. 1-3 diameter	(2.559-2.5598 in.)	(2.5708 in.)
b) Bearing No. 4 diameter	50.00-50.03 mm	50.4 mm
	(1.9685-1.9696 in.)	(1.984 in.)
2 - Bore for seal at flywheel		
end diameter	90.00-90.05 mm	—
	(3.5433-3.5452 in.)	
3 - Bore for camshaft bear-		
ings diameter	27.50-27.52 mm	—
	(1.0826-1.0834 in.)	
4 - Bore for oil pump housing diameter	70.00-70.03 mm	—
	(2.7559-2.7570 in.)	
5 - Bore for cam followers . diameter	19.00-19.02 mm	19.05 mm
	(0.7480-0.7488 in.)	(0.750 in.)

M

Type 1 Engine (assembly)

cardiagn.com

Type	1/1600 1/Model 181	
	New part	Wear limit
10 - Crankshaft bearing/ crankshaft		
Bearings 1 and 3 radial play	0.04–0.10 mm (0.0016–0.004 in.)	0.18 mm (0.0071 in.)
Bearing 2 radial play	0.03–0.09 mm (0.0012–0.0035 in.)	0.17 mm (0.0067 in.)
Bearing 4 radial play	0.05–0.10 mm (0.002–0.004 in.)	0.19 mm (0.0075 in.)
..... end play	0.07–0.13 mm (0.0028–0.0051 in.)	0.15 mm (0.0059 in.)
11 - Flywheel lateral runout (measured at center of friction surface)	max. 0.30 mm (0.0118 in.)	—
..... imbalance	max. 20 cmg	—
Shoulder for oil seal outside diameter	69.9–70.1 mm (2.7519–2.7598 in.)	69.4 mm (2.7322 in.)
Machining of tooth width	—	max. 2.0 mm (0.08 in.)
12 - Drive plate imbalance	max. 5 cmg	—
Clutch		
1 - Complete clutch out of balance	max. 15 cmg	—
2 - Pressure plate runout	—	0.10 mm (0.004 in.)
3 - Release ring runout	max. 0.3 mm (0.012 in.)	0.4 mm (0.016 in.)
4 - Flywheel/release ring .. distance	26.7–27.3 mm (1.051–1.075 in.)	—
5 - Clutch springs color	white red	—
Length loaded	29.2 mm 29.2 mm (1.149 in.) (1.149 in.)	—
Load new	44.5–49.5 kg 34–37 kg (99–100 lb) (75–81 lb)	—
Load settled	39–44 kg 29.5–32.5 kg (86–97 lb) (66–72 lb)	—
6 - Clutch plate runout [measured at 195 mm (7.677 in.) diameter]	max. 0.5 mm (0.02 in.)	—
7 - Free play at clutch pedal	10–20 mm (³ / ₈ – ³ / ₄ in.)	—

Engines for vehicles with manual transmission

General

Engine testing should cover the following points:

- 1 - Preliminary inspection
- 2 - Warmup
- 3 - Fuel consumption test
- 4 - Output test
- 5 - Final inspection

Completely or partly reconditioned engines should also be tested in this way. A test stand with water brake is most suitable for these tests. On this type of stand the load on the engine can be adjusted to suit the performance and fuel consumption test conditions.

Preliminary check

- a - Adjust valve clearance.
- b - Adjust contact points and set ignition.
- c - Check belt tension.
- d - Fill the engine with oil (see M 1.1/1-1).

Warming up

Prior to starting, crank the engine several revolutions by hand. If the engine has not been in operation for a long period, it is advisable to inject a few drops of oil into the air intake opening of the carburetor while starting the engine.

After the engine has been started, the oil pressure warning light must go out immediately as the engine speed increases. Otherwise the oil pump has not picked up any oil to feed bearings and friction surfaces.

The generator warning lamp should also go out at a fast idle speed.

When the engine starts running check for leaks at fuel pump, fuel lines and carburetor. Check fuel pump pressure.

The warmup period on the test bench may generally be limited to 30 minutes. The engine should run:

- 10 minutes at 1500 rpm with minimum load.
- 20 minutes at 2500 rpm with increased load.

Fuel consumption test

Check the fuel consumption at the end of the 30 minute warmup period, using a suitable measuring glass and a stop watch. At a fixed speed and load the fuel consumption can be determined from the time taken to consume a given amount of fuel.

	Engine speed rpm	Brake load kg (lb.)	Seconds to consume 100 ccm
up to July 1970	2900 4000 (full throttle)	6.5 (14.3) at least 11.2 (24.5)	51—55 21.5—22.5
from Aug. 1970	2500 4000 (full throttle)	5.7 (12.3) at least 11.4 (24.7)	55—65 19.0—20.5

Output test

After the fuel consumption test, the engine output is tested and compared with the values given in the output graph. A variation of $\pm 5\%$ is permissible to compensate for manufacturing tolerances and differences in test conditions.

The correction factor "f" is found in the diagram by using the measured intake air temperature and the barometric pressure.

The engine output is dependent on the oil temperature. The output test should, therefore, be carried out at an oil temperature of at least 80° C (176° F) in the crankcase.

Final inspection

- 1 - Set idling speed while engine is warm.
- 2 - Check for oil leaks.

After the full-load and fuel consumption test, the engine should be checked for oil leaks. Special attention should be paid to push rod tubes, oil pump, oil cooler, cylinder head covers and the crankcase joint.

- 3 - Check the compression.

The compression is checked with the throttle fully open and the engine warm. The spark plugs are removed and the engine turned over with the starting motor.

- 4 - Re-check.

Before installation in the vehicle, check valve clearance and belt tension. The air cleaner should be clean and filled with the required amount of oil.

Storage of engines

Engines which are to be stored for a long time must be specially treated to prevent corrosion. All remaining traces of fuel and combustion gases will become chemically active and attack the cylinder walls, valve guides, etc.

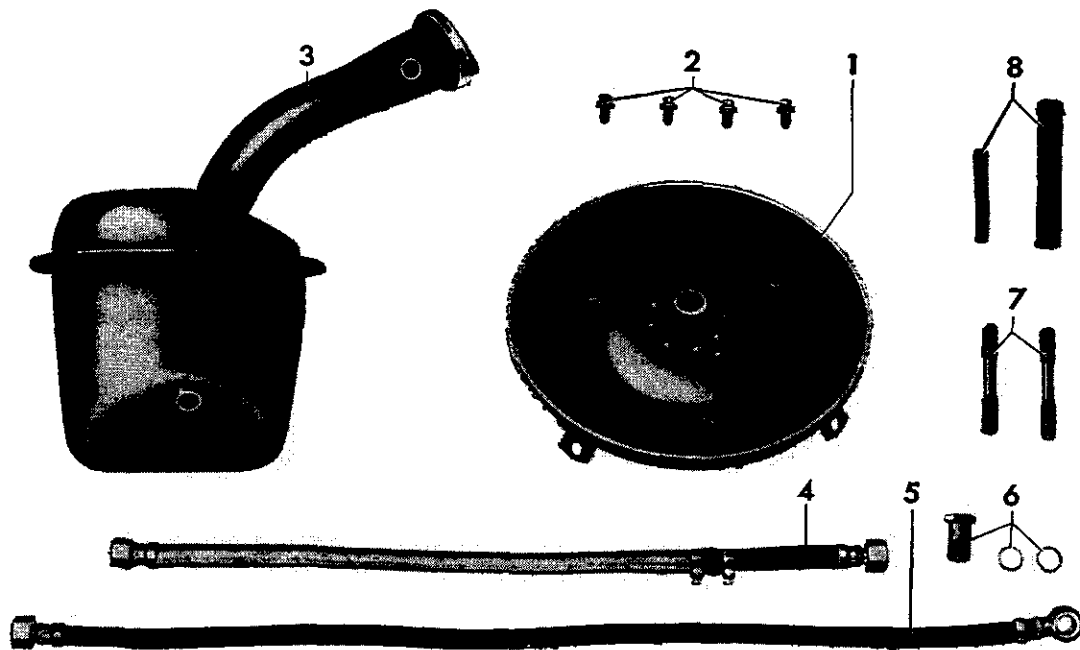
To prevent damage of this kind, it is recommended that anti-corrosion oil be injected through the carburetor air intake during the last engine revolutions.

The spark plugs can also be removed and anti-corrosion oil injected directly into each cylinder. The exterior of the engine should be sprayed with anti-corrosion oil.

Special instructions for engines for vehicles with Automatic Stick Shift

When testing engines for vehicles with Automatic Stick Shift on a test stand, additional preparations are necessary. These engines have drive plates instead of the flywheel, additional vacuum connections on carburetor, manifold or balance pipe and a second oil pump for the converter ATF feed and bolts instead of the two engine mounting studs.

The following additional parts are required and should be available at every test stand:



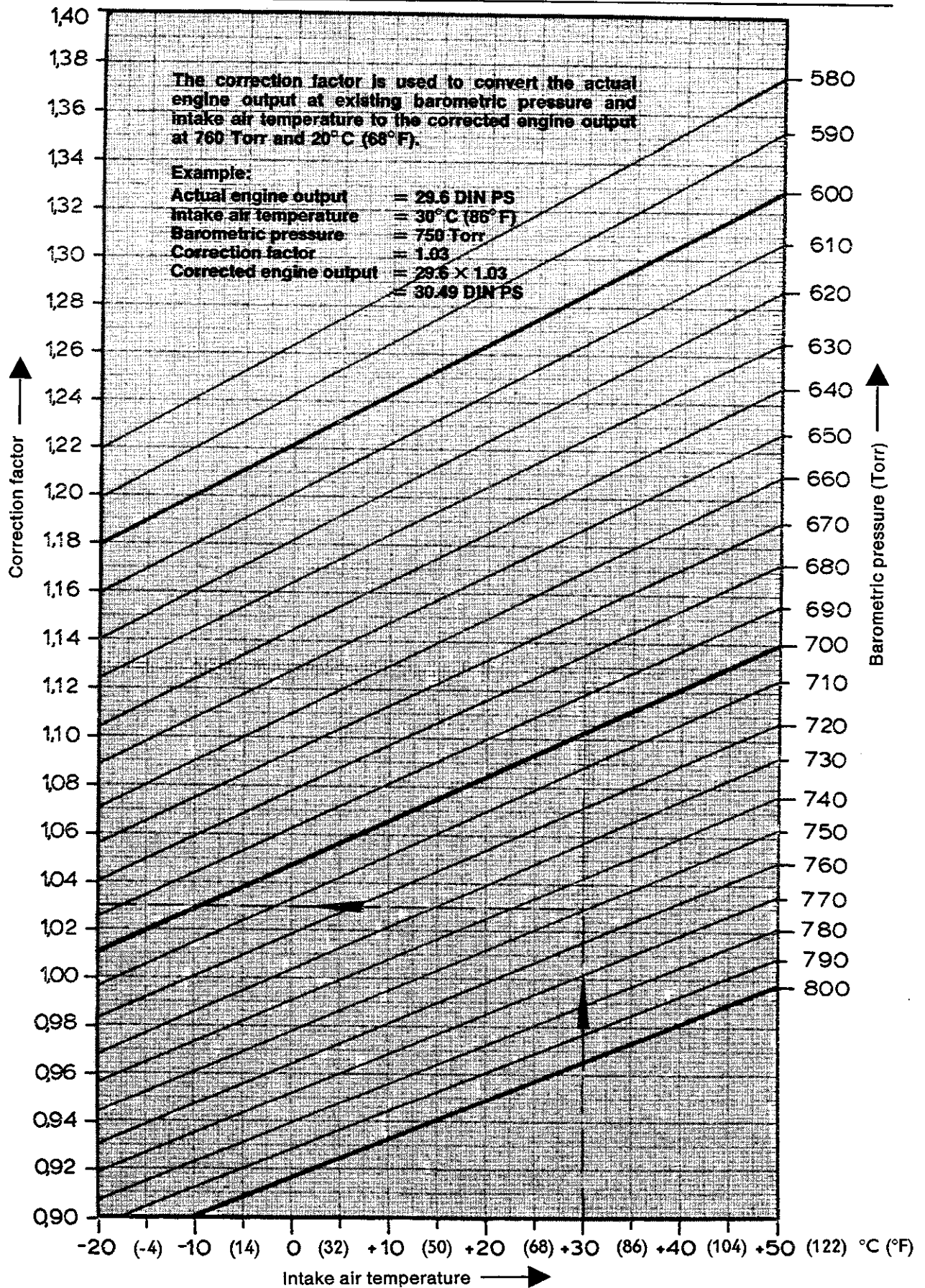
- 1 - Drive flange
- 2 - 4 twelve points bolts
- 3 - ATF tank with dipstick (cap)
- 4 - ATF pressure hose with suction hose and approx. 2 quarts of ATF

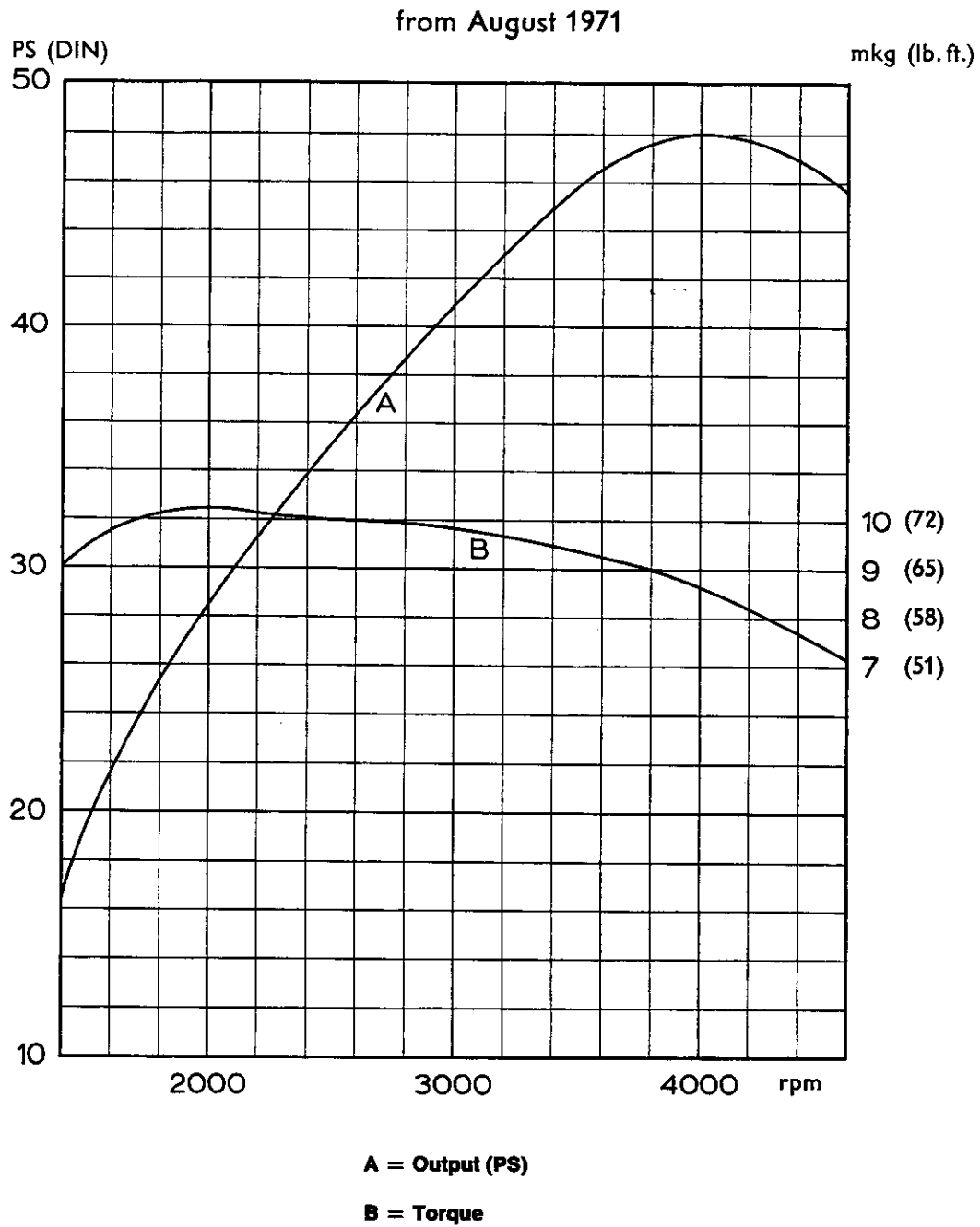
- 5 - ATF return hose
- 6 - Union bolt with two washers
- 7 - 2 studs AM 10×82
- 8 - Plugged hose



Installation instructions

- 1 - Attach drive flange to drive plate on engine with the four twelve point bolts.
- 2 - Install the two lower engine mounting studs into the crankcase.
- 3 - Connect ATF tank to dual pump.
- 4 - Seal the vacuum connections on carburetor and intake manifold.





Testing and checking engines

General

Engine testing should cover the following points:

- 1 - Preliminary inspection
- 2 - Warming up
- 3 - Fuel consumption test
- 4 - Output test
- 5 - Final inspection

Fully and partly reconditioned engines should also be tested in this way. A test stand with water brake is most suitable for these tests. On this type of stand the load on the engine can be adjusted to suit the performance and fuel consumption test conditions.

Preliminary check

- a - Adjust valve clearance.
- b - Adjust contact points and set ignition.
- c - Check belt tension.
- d - Fill the engine with oil (see M 1.3/1-1 for quantity).

Warming up

Prior to starting, crank the engine several revolutions by hand. If the engine has not been in operation for a long period, it is advisable to inject a few drops of oil into the air intake opening of the carburetor while starting the engine.

After the engine has been started, the green oil pressure warning light must go out immediately as the engine picks up speed. Otherwise the oil pump has not picked up any oil to feed bearings and friction surfaces.

The red generator warning lamp should also go out at a fast idle speed.

After the engine has been started check for leaks on fuel pump, fuel lines and carburetor. Check fuel pump pressure.

The warm up period on the test bench may generally be limited to 30 minutes. The engine should run:

10 minutes at 1500 rpm with 3 kg (6.6 lb.) load.

20 minutes at 2500 rpm with 6 kg (13.2 lb.) load.

Fuel consumption test

Check the fuel consumption at the end of the 30 minute warm up period, using a suitable measuring glass and a stop watch. At a fixed speed and load the fuel consumption can be determined from the time taken to consume a given amount of fuel.

	Engine speed rpm	Brake load kg (lb.)	Seconds to consume 100 cc
1/1200	2200	5.0 (11)	84.5—91.5
	3600 (full throttle)	at least 9.1 (20)	30—33
1/1300	2500	5.7 (12.5)	66.5—71.5
	4000 (full throttle)	at least 9.6 (21)	25.5—27.5
1/1600	2900	6.5 (12.5)	51—55
	4000 (full throttle)	at least 10.2 (22.5)	21.5—22.5
2/1600	2400	5.6 (12.3)	65—70
	4000 (full throttle)	at least 11.0 (24)	20.5—23.0
3/1600	2500	5.7 (12.5)	65—70
	4000 (full throttle)	at least 12.8 (28.2)	18.5—20.5
3/1600 M 236	2900	6.5 (12.5)	51—55
	4000 (full throttle)	at least 10.5 (23)	18—20

M1.6 Testing and Checking Engines, Output Graph

Output test

After the fuel consumption test, the engine output is tested and compared with the values given in the output graph. A variation of $\pm 5\%$ is permissible to compensate for manufacturing tolerances and differences in test conditions.

Note the following to obtain accurate test results:

- 1 - Connect generator or regulator to the electrical circuit on the test stand.
- 2 - Install damper pipe or tail pipes on the muffler.
- 3 - Open the flaps on the heat exchangers and connect flexible metal hoses.

3/1600:

- 4 - Close the fresh air pipes.
- 5 - Check engine oil temperature with the thermometer on the test stand.
- 6 - Measure intake air temperature.
- 7 - Find corrected engine output with the aid of the correction factor.
- 8 - Extract exhaust gas as well as heating and cooling air.

Additional notes to above points:

To point 5:

The engine output is dependent on the oil temperature. The output test should, therefore, be carried out at the following oil temperatures:

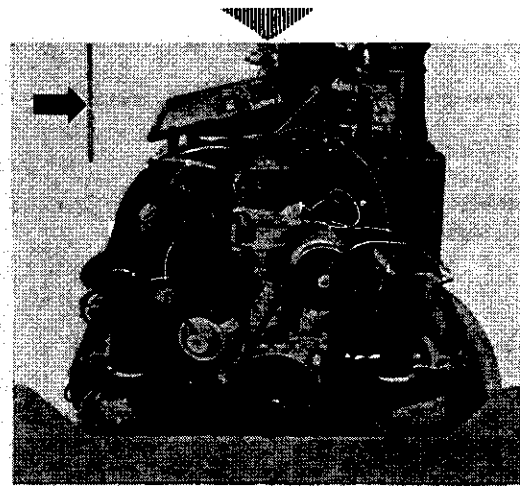
Type 1, 2 and Industrial Engine: at least 80°C (176°F) in crankcase

Type 3: at least 60°C (140°F) in oil filler neck

The temperatures are different because of the location of the temperature sensing unit. (Types 1—2 in the crankcase, type 3 in the oilfiller neck.)

To point 6:

To establish the correction factor, it is necessary to measure the temperature of the intake air about 10—15 cm (4—6 in.) away from the air cleaner during the test.



To point 7:

The engine output is influenced by barometric pressure and temperature. Therefore, it is necessary to adjust the actual output of an engine to certain standard operating conditions. According to DIN 70020, these standard conditions are 20°C (68°F) and 760 Torr (= 760 mm Hg or 29.92 in. Hg). The engine output based on these figures is called "Corrected output".

The various factors (and their units of measurement) that must be considered in the calculation of engine output and torque are:

Actual brake load	= F_e (kg)
Corrected brake load	= F_{red} (kg)
Engine speed	= n (rpm)
Actual engine output	= P_e (bhp)
Corrected engine output	= P_{red} (bhp)
Intake air temperature	= t ($^{\circ}\text{C}$)
Barometric pressure	= b (Torr)
Correction factor	= f
Torque	= M_d (mkg)

The values needed to check the performance of the engine are computed on the basis of the following equations:

- 1 - Actual engine output: $P_e = \frac{F_e \cdot n}{1000}$ (bhp)
- 2 - Corrected engine output: $P_{red} = P_e \cdot f$ (bhp)
- 3 - Corrected engine output: $P_{red} = \frac{F_e \cdot n}{1000} \cdot f$ (bhp)
- 4 - Correction factor: $f = \frac{760}{b} \cdot \sqrt{\frac{273+t}{293}}$
- 5 - Torque: $M_d = F_{red} \cdot 0.716$

These equations are represented graphically on pages M 1.6/1-4 to M 1.6/1-6. The diagrams are read in the following manner:

Correction Factor Diagram

The correction factor is found by using the measured intake air temperature and the barometric pressure.

Output Diagram

The actual engine output is found by reading the actual brake load at the given engine speed.

The corrected engine output can now be established by multiplying the actual engine output with the correction factor. This method should be used whenever the engine performance test is conducted under extreme weather conditions.

Consolidated Diagram

In this diagram the corrected engine output can be read directly. In the lower left hand part of the coordinate system, the correction factor is obtained from the intake air temperature and the barometric pressure. The field on the upper left yields the values for corrected brake load and torque on the basis of the actual brake load and the correction factor.

On the right hand side of the coordinate system, the corrected engine output can be determined by reading right from the vertical axis to the engine speed and down to the horizontal axis.

Note: Always read parallel to the coordinates. For further details see examples in each diagram.

To point 8:

Exhaust gases have to be emitted outdoors because they contain poisonous carbon monoxide. Assure good ventilation of the test room.

To avoid overheating the engine (output drop), it is advisable to extract cooling and heating air as well.

Final Inspection

a - Set idling speed while engine is warm.

b - Check for oil leaks.

After the full-load and fuel consumption test, the engine should be checked for oil leaks. Special attention should be paid to push rod tubes, oil pump, oil cooler, cylinder head covers and the crankcase joint.

c - Check the compression.

The compression is checked with the throttle fully open and the engine warm. The spark plugs are removed and the engine turned over with the starting motor.

d - Re-check.

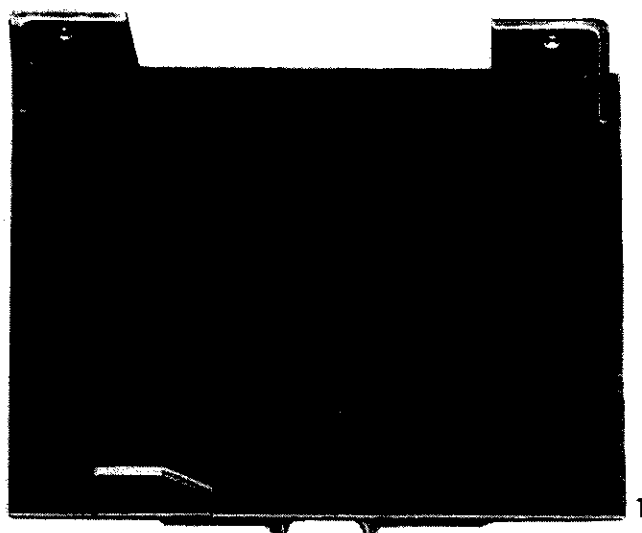
Prior to installation in the vehicle, check valve clearance and belt tension. The air cleaner should be clean and filled with the required amount of oil.

e - Storage of engines.

Engines which are to be stored for a long time must be specially treated to prevent corrosion. All remaining traces of fuel and combustion gases will become chemically active and attack the cylinder walls, valve guides, etc. To prevent damage of this kind, it is recommended that anti-corrosion oil be injected through the carburetor air intake during the last engine revolutions. The spark plugs can also be removed and anti-corrosion oil injected directly into each cylinder. The exterior of the engine should be sprayed with anti-corrosion oil.

Checking on a vehicle test stand

The output and fuel consumption can be measured on a vehicle test stand when the engine is installed. Test conditions and values for this type of test are given in the respective specification charts.



No.	Description	Special tool	Remarks
1	Support for engine jack	VW 612/2	
2	Clip for fuel line	VW 647	
3	Union M16×1.5		soldered up
4	Retaining plate for converter	VW 802	

Removing

1 - Disconnect ground strap from battery.

2 - Remove air cleaner.

3 - Up to Engine No. H 5924 000:

Remove throttle positioner.

4 - Remove nuts from two upper engine mounting bolts.

Note

From August 1970, a special nut is pressed into crankcase on upper left side. On these engines the bolt must be inserted from the transmission side.

5 - Disconnect wires from generator, ignition coil, oil pressure switch and carburetor.

6 - Disconnect accelerator cable from carburetor.

7 - Pull fuel hose off and plug it.

8 - Disconnect both heater flap cables and detach heater pipes from engine.

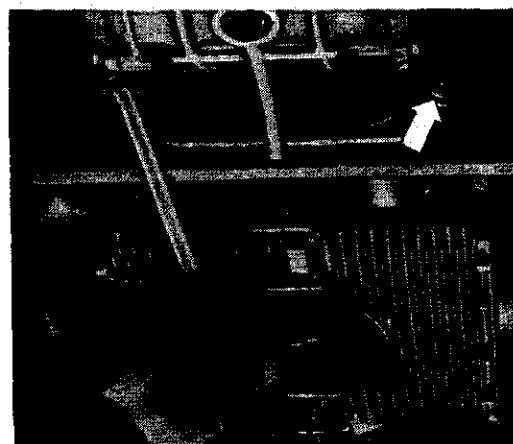
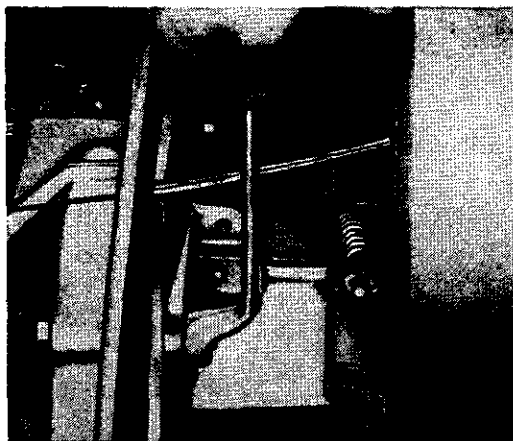
9 - Pull accelerator cable out of guide tube.

10 - Remove two nuts from lower engine mounting bolts (arrow).

11 - Remove engine downward.

Caution

Take care not to damage the main drive shaft, clutch and clutch plate.



Installing

- 1 - Check clutch release bearing for wear and replace if necessary.

Roughen up the plastic ring with coarse emery and lightly rub in molybdenum disulfide paste.

- 2 - Rub molybdenum disulfide powder lightly into splines of drive shaft with a clean cloth.

- 3 - Lubricate starter bushing lightly with multi-purpose grease.

- 4 - Clean transmission case and engine flange.

- 5 - If the damping material in the engine compartment is loose, secure it properly before installing engine.

- 6 - When inserting the engine and guiding it over the main drive shaft, take care not to damage the shaft, the clutch plate and the release bearing.

It is advisable to turn the engine back and forth with the belt pulley (engage a gear).

- 7 - When installing the engine, locate the lower studs in the transmission flange first then insert upper bolts. Tighten nuts uniformly.

- 8 - Adjust clutch pedal free play.

- 9 - Install engine seal properly.

- 10 - Adjust accelerator cable at full throttle.

- 11 - Adjust ignition.

The following sequence of operations is recommended when disassembling and assembling the engine:

Disassembling

- 1 - Drain engine oil.
- 2 - Remove front cover plate.
- 3 - Remove rear cover plate.
- 4 - Remove muffler.
- 5 - Remove heat exchangers (left and right).
- 6 - Remove fan housing complete with generator.
- 7 - Remove intake manifold complete with pre-heating pipe.
- 8 - Remove generator support.
- 9 - Remove cylinder cover plates (left and right).
- 10 - Remove crankshaft pulley.
- 11 - Remove distributor and fuel pump.
- 12 - Remove distributor drive shaft.
- 13 - Remove oil cooler.
- 14 - Remove rocker arm shafts.
- 15 - Remove cylinder heads.
- 16 - Remove cylinders.
- 17 - Remove pistons.
- 18 - Remove clutch.
- 19 - Remove flywheel.
- 20 - Remove oil pump and strainer.
- 21 - Split crankcase.
- 22 - Take out camshaft and crankshaft.

Assembling

Proceed in reverse order. Additional instructions are found on following pages.

Ignition System

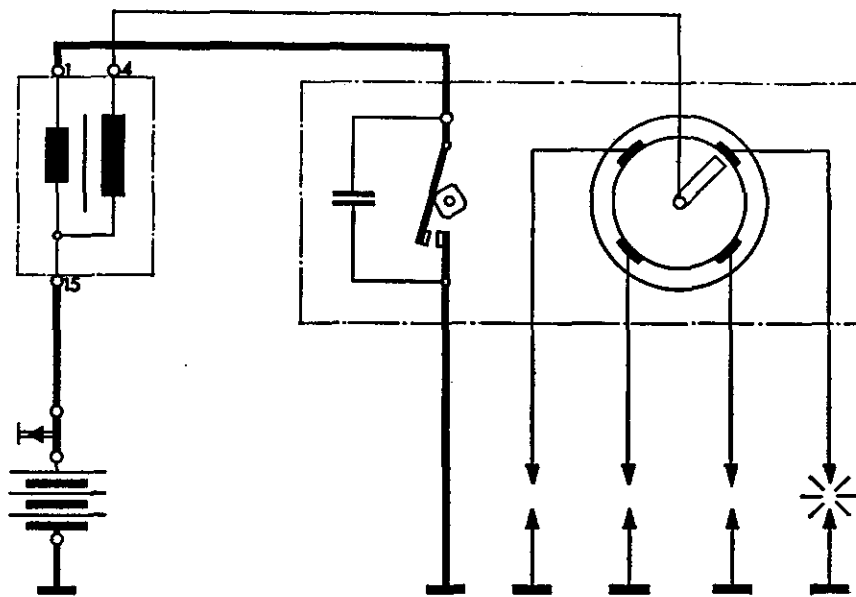
The ignition system is a battery type.

The battery voltage is stepped up in the coil to 15,000–20,000 volts as in a transformer. This takes place as follows:

As the distributor shaft rotates (driven by the crankshaft), the integral contact breaker cam opens the contact points.

lapses and induces a high voltage surge in the secondary winding.

This high voltage surge passes through an ignition cable to the rotor in the distributor. The tip of the rotor is just opposite the contact in the distributor cap to which the spark plug in the cylinder to be fired is connected.



This interrupts the flow of current in the primary windings of the coil. The magnetic field built up in the two windings by the flow of current col-

A spark jumps across the plug electrodes and ignites the compressed fuel/ air mixture in the cylinder.

Ignition coil

The coil consists of a laminated iron core around which is wrapped a few turns of thick wire to form the primary winding and a large number of turns of thin wire to form the secondary winding. The beginning of the secondary

winding is attached to the iron core to which the high voltage cable is connected. The end of the secondary winding is connected to the beginning of the primary winding and both are connected to terminal 1 on the coil.

Distributor

The distributor provides a means of distributing the ignition current to each of the four spark plugs in the correct sequence and exactly at the firing point.

The distributors are fitted with a vacuum or combined centrifugal and vacuum spark control arrangement to ensure that the ignition timing is automatically varied to suit all engine speeds and load conditions.

weights by a small link so that cam is turned in the direction of rotation of the distributor shaft and the ignition timing is advanced. Return springs pull the weights back to the initial position as the speed drops.

Vacuum spark control

The vacuum advance mechanism controls the firing point according to engine load and speed. There are **two** vacuum drillings in the carburetor, one in the venturi and one near the throttle valve. The drilling in the venturi gives a speed-sensitive vacuum advance and the drilling near the throttle valves gives a load-sensitive advance.

The depression created in the carburetor is routed to the vacuum unit on the distributor. A diaphragm in the vacuum unit is moved by the vacuum and a pull rod transmits the movement of the diaphragm to the contact breaker plate and turns it against the direction of rotation of the cam on the distributor shaft. When the depression ceases, a return spring moves the breaker plate back to its original position.

Centrifugal and vacuum spark control

1 - Centrifugal control

Two weights on a carrier plate fly outward as the distributor speed increases. The contact breaker cam is connected to the

2 - Single vacuum control

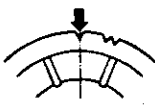
a - The vacuum taken from the carburetor via **one** drilling near the throttle valve acts mainly in the part load range in addition to the centrifugal advance and turns the breaker contact plate against the direction of rotation of the cam on the distributor shaft.

b - Double vacuum control

The vacuum is taken in front of and behind the throttle valve and led in separate lines to the two chambers in the vacuum unit. The diaphragms of these chambers are connected by a rod to the breaker contact plate which is moved either in the direction of distributor shaft rotation to retard the spark timing or against the direction of distributor shaft rotation to advance the spark timing.

To give the retarded timing required at idling speed the vacuum is taken from behind the fully closed throttle valve and acts on the breaker contact plate via the ring-shaped diaphragm.

When the throttle valve is opened, the vacuum in the drilling in front of the throttle valve increases and the breaker contact plate is moved in the direction of advanced timing.

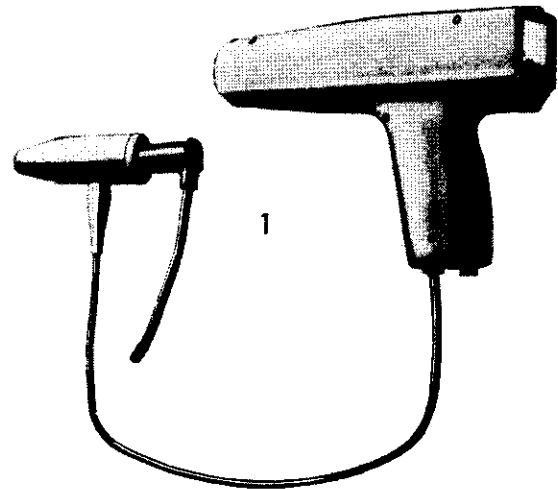
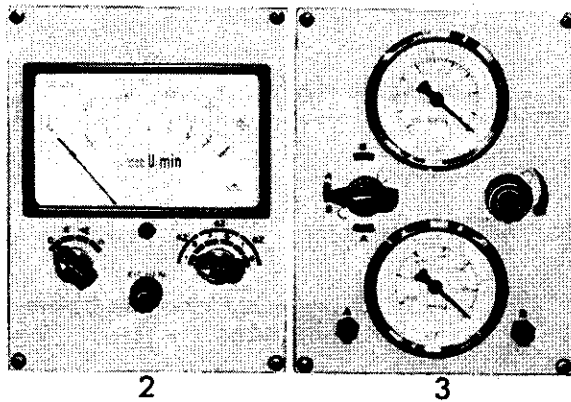
Model		1/Manual Transmission 1/Model 181				
Code letters		B	AE	AE, AH, AK	AK	AM
Used	from	11 Aug. 1969	1 Aug. 1970	1 Aug. 1971	1 April 1973	1 April 1973
Engine No.	from	B 6 000 001	AE 000 001	AE 558 001 AH, AK 000 001	AK 1 200 009	AM 000 001
Distributor Production		113 905 205 T	113 905 205 AJ	113 905 205 AN	043 905 205	113 905 205 AN 043 905 205 C
Distributor Replacement		111 905 205 AA	113 905 205 AJ	113 905 205 AN	043 905 205	043 905 205 C
Ignition timing		0°	5° after TDC		7.5° before TDC	5° after TDC
Timing marks						
Speed	rpm	800—900				
Vacuum hose or hoses		off	on		off	on
Dwell angle	set to	44—50°				
	wear limit	42—58°				
Centrifugal spark control						
	Begin rpm		1000—1250	1000—1250	1050—1250	1000—1250
	rpm		1500	1500	1500	1500
	Degrees		6—12	6—12	6—12	6—12
	rpm					
	Degrees					
End	rpm		3800	3800	3800	3800
	Degrees		22—25	22—25	22—25	22—25
Vacuum spark control advance						
	Begin mmHg	3—7	110—160	110—160	60—100	110—160
	mmHg	30				
	Degrees	17—19				
End	mmHg	70—76	210—240	180—200	200	180—200
	Degrees	32—35	9—12	5—8	8—12	5—8
Vacuum spark control retard						
	Begin mmHg		80—130	80—150		80—150
End	mmHg		160—230	160—230		160—230
	Degrees		11—13	11—13		11—13
Spark plugs ¹⁾		below +25° C (77° F)		W 145 T 1		
		above +25° C (77° F)		W 175 T 1		

¹⁾ Or plugs from other manufacturers with equivalent heat values and approved by VW factory.

M Type 1 Ignition System

Model		1/Automatic Stick Shift			
Code letters		B	AE, AH	AH	AK
Used	from	11 Aug. 1969	1 Aug. 1970	1 April 1973	1 Aug. 1972
Engine No.	from	B 6 000 002	AE 000 002	AH 090 024	AK 000 001
Distributor Production		113 905 205 AD 113 905 205 AE	113 905 205 AH	043 905 205 A	113 905 205 AH
Distributor Replacement		113 905 205 AE	113 905 205 AH	043 905 205 A	113 905 205 AH
Ignition timing		0°	5° after TDC	7.5° before TDC	5° after TDC
Timing marks					
Speed	rpm	800—900			
Vacuum hose or hoses		on	off	on	
Dwell angle	set to	44—50°			
	wear limit	42—58°			
Centrifugal spark control					
	Begin rpm	1050—1200	1000—1200	1000—1200	1000—1200
	rpm	1700	1600	1600	1600
	Degrees	13—15	12—15	12—15	12—15
	rpm	2200	2200	2200	2200
End	Degrees	13—16	12—16	12—16	12—16
	rpm	3900	3800	3800	3800
	Degrees	25—28	22—25	22—25	22—25
Vacuum spark control advance					
Begin	mmHg	70—120	110—160	60—100	110—160
	mmHg				
End	mmHg	240	150—170	200	150—170
	Degrees	8—12	2—5	8—12	2—5
Vacuum spark control retard					
Begin	mmHg	60—100	80—130		80—130
	mmHg				
End	mmHg	170	160—230		160—230
	Degrees	6—8	11—13		11—13
Spark plugs ¹⁾		below +25° C (77° F)	W 145 T 1		
		above +25° C (77° F)	W 175 T 1		

¹⁾ Or plugs from other manufacturers with equivalent heat values and approved by VW factory.



No.	Description	Special tool	Remarks
1	Stroboscopic timing light		
2	Dwell angle — tachometer tester		
3	Vacuum measuring gauge		range 0—100 and 0—600 mm Hg

Coil

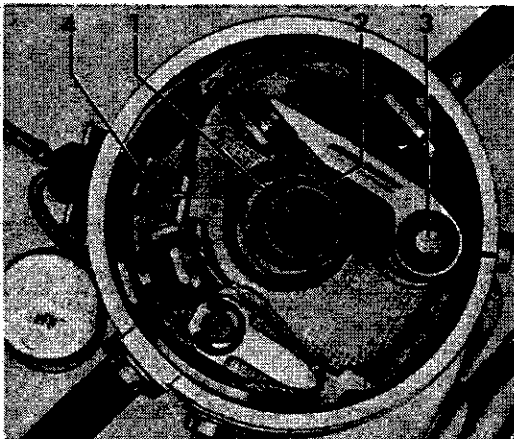
Keep coil cap clean and dry.

Distributor

- 1 - Check points for pitting and build-up, replace if necessary.
- 2 - Lubricate fiber block on breaker arm with a small amount of multi-purpose grease.
- 3 - Lubricate breaker arm bushing and felt wick in shaft with a drop of engine oil.
- 4 - Check that distributor cap is clean. Check for cracks and arcing marks. Clean or replace as necessary.
- 5 - Check and adjust dwell angle.
- 6 - Check timing and adjust if necessary.

Spark plugs

Clean, check gaps and adjust.



Special instructions (lubrication)

- A - The felt wick in the distributor shaft (1) and the contact arm bushing (3) should be lubricated with a few drops of engine oil regularly.
- B - The fiber block on the breaker arm must be lubricated with multi-purpose grease. To avoid the risk of grease getting on to the contact points, use only a very small quantity and press it into the corner between fiber block and breaker arm (2) and on the ball (4).

- 5 - Run engine at 1000 to 1200 rpm and note dwell meter reading.

Evaluating meter readings:

Dwell angle: 42°—58°

The point gap must not be less than .012 in. (0—3 mm). If the dwell angle reading shows that a smaller gap is necessary (measured with feelers) there is a **mechanical defect in the distributor**.

- 6 - Run engine at 2000—2500 rpm and check reading again.

When the speed is increased, the dwell angle must not alter noticeably (max. $\pm 1^\circ$). Large deviations indicate **defects in distributor**, such as worn bearings or a worn cam.

Note:

Small breaker gap = large dwell angle
Large breaker gap = small dwell angle

Unsteady, jerky movements of the needle are usually caused by burned and **unservicable breaker points**.

Adjusting contact points with feeler gauge

The contact points should only be adjusted with a feeler gauge if a dwell meter is not available. Even when there is only a small build-up on the points, the points can no longer be set accurately by this method.

- 1 - Remove distributor cap and rotor.
- 2 - Turn the crankshaft until the breaker arm is fully lifted by the cam.
- 3 - Loosen the screw holding the fixed contact point.

- 4 - Insert screwdriver between the two small pins on the contact breaker plate and in the slot at the end of the fixed point. Turn the screwdriver until the clearance is .016 in. (0.4 mm).

- 5 - Tighten lock screw.

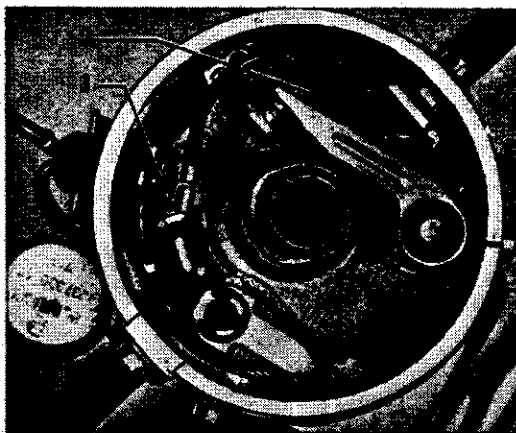
Important

When the contact points have been adjusted, the ignition timing must be reset as an alteration of .004 in. (0.1 mm) in the breaker gap alters the ignition timing about 3° .

Normal wear of the rubbing block allows the contact point gap to close, causing the points to burn rapidly with subsequent engine misfiring.

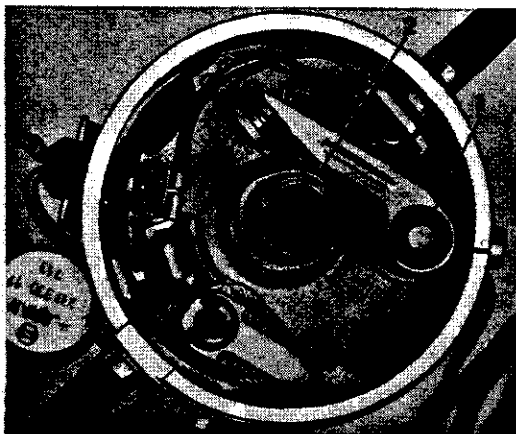
Removing

- 1 - Disconnect wire (1).
- 2 - Remove screw (2).



Installing

- 1 - Lubricate contact pivot (1) with one drop of engine oil.
- 2 - Lubricate cam and fiber block (2) with the enclosed grease capsule.
- 3 - Remove any oil or grease which may have gotten on the points accidentally.
- 4 - Adjust points.

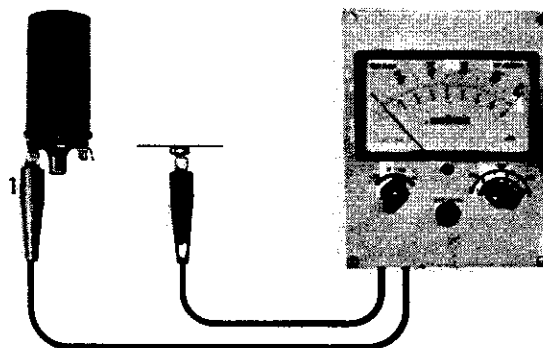


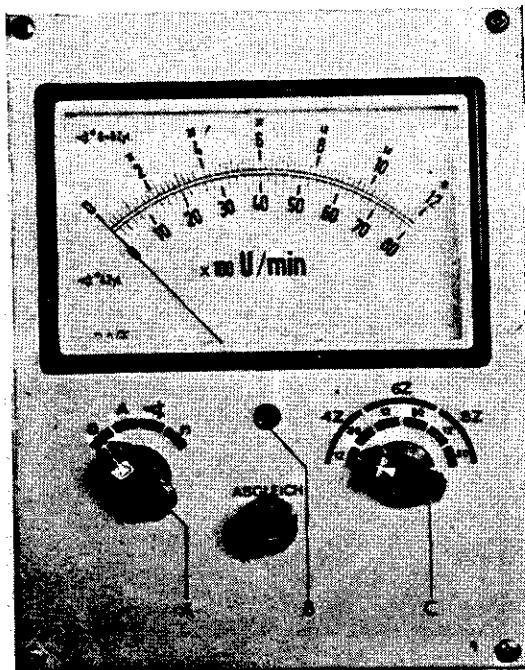
Adjusting dwell angle

If the dwell angle tester used is different from the one shown here, the appropriate instructions for use must be followed.

- 1 - Connect tester:

Connect green clip to terminal 1 on coil and black clip to a metal part.





A - Test selection switch
B - Zeroing screw
C - Measuring range selection switch

2 - Calibrate the tester:

Set test selection switch to "A". Turn knob of calibrating switch until the needle is exactly on the end mark (12 or 80) of the scale.

3 - Measure dwell angle.

Set test selection switch to "A" and measuring range selection switch to 4 Z (number of cylinders).

Start engine and run it at about 1000 rpm. Read off dwell angle on lower scale (1 graduation = 2°).

Then increase engine speed to about 2000 rpm. The needle must not deviate more than $\pm 1^\circ$ from the previous reading. If it does, it indicates that the distributor shaft or the breaker plate is worn. In such cases remove distributor and replace breaker plate.

Compare readings with specified figures.

Specified dwell angle	44–50°
Wear limit	42–58°

This means that **new** contacts must be adjusted to the specified figure and that worn contacts should not be adjusted as long as the dwell angle is within the wear limit.

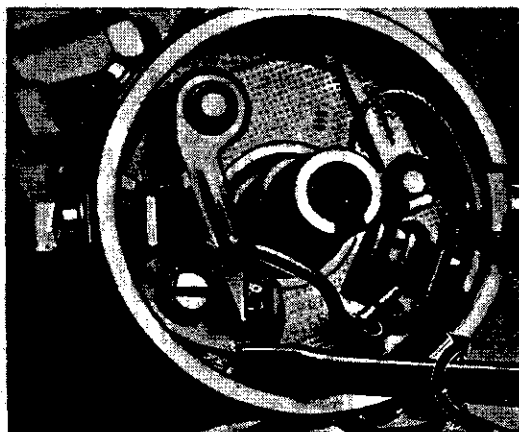
4 - Adjust dwell angle.

Take distributor cap and rotor arm off and loosen screw holding the contacts. With ignition switched on and starter turning the engine over, alter the contact gap until the correct angle can be read on the tester. Tighten contact securing screw and check again to see that the angle has not changed as the screw was being tightened.

5 - Install rotor arm and distributor cap and check dwell angle again.

Note

When the dwell angle has been adjusted, the ignition timing must also be readjusted.



If the instrument used is different from the one shown here, the appropriate instructions for use must be followed.

- 1 - Check dwell angle, if necessary adjust.
- 2 - Engine oil temperature 30–70° C (86 to 158° F).
- 3 - Connect the dwell angle tester and calibrate it. Set test selection switch to "n". Set measuring range selection switch to "4 Z" and to "12" in this group.

The speed is read off on the upper or lower scale.

- 4 - Connect stroboscopic timing light. The impulse unit is connected in the No. 1 cylinder plug cable as shown. The adjusting disc in the handle must be turned back to the zero stop.

- 5 - **Only if specified:**

Pull vacuum hose or hoses off the vacuum unit on the distributor (see table M 3.2/1).

- 6 - Run engine at the given speed 800–900 rpm.

Note

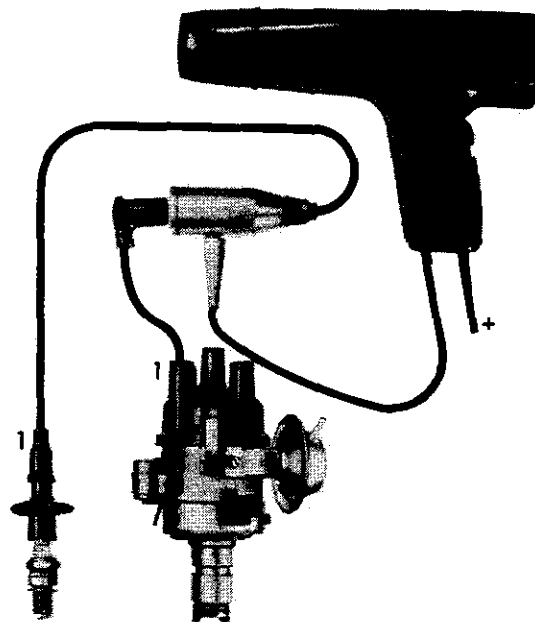
Set engine to specified speed with throttle valve closed by turning the bypass air screw.

- 7 - Check ignition timing:

The mark on the pulley must be in line with the crankcase joint.

- 8 - Adjust ignition timing:

Turn distributor until the setting mark aligns with the reference mark (see M 3.2/1).



If the instruments used are different from those shown in the list of tools the appropriate instructions for use must be followed.

1 - Connect dwell angle tester and trim it. Set test selection switch to "n". Set measuring range selection switch to "4 Z" and to "80" in this group. The speed is read off on the lower scale.

2 - Connect stroboscopic timing light.

3 - Start engine, check basic ignition timing and rectify as necessary.

4 - **Pull hose or hoses off the vacuum unit on distributor.**

5 - Run engine at 900 rpm. and direct flashes onto the timing mark.

The setting may deviate from the basic setting due to the absence of the vacuum connections and this should be "brought back" with the aid of the adjusting disc on the control angle measuring instrument. Note the reading.

6 - Increase speed slowly. The start of the spark advance will be shown by the movement of the timing mark.

7 - Set the speed to the figure given in the table (see M 3.2). "Bring the mark back" with the aid of the disc on the control angle measuring instrument. Read off the advance in degrees on the instrument and subtract the reading at point 5 to obtain the centrifugal spark control.

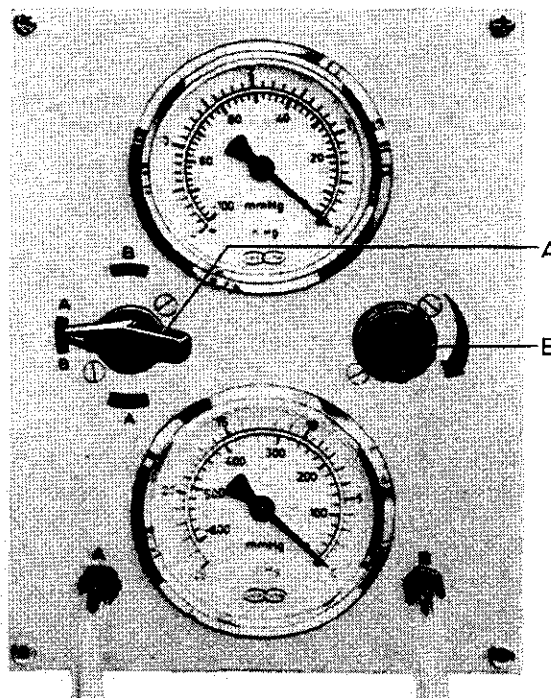
8 - If the test results do not agree with the specified figures, the control mechanism in the distributor must be repaired (freed up, weak springs replaced) or a new distributor installed.

- 1 - Pull hose off vacuum unit on carburetor and connect hoses of **vacuum tester** to engine so that connection "A" is connected to the vacuum unit and connection "B" to the carburetor.

- 2 - Connect stroboscopic timing light (see page 3.3/2).

- 3 - Set change-over knob to "B" and close control valve. Start engine. If no vacuum is show, the vacuum connection in the carburetor is blocked.

If vacuum is present, move change-over knob to "AB" and increase speed until a reading of at least 100 mmHg is recorded. Then move knob to "A" and switch engine off. The indicated vacuum must remain constant for at least 1 minute, otherwise the vacuum unit or the hose is leaking.



A - Change-over knob

B - Control valve

- 4 - Move knob to "AB" and open control valve. Start engine, check basic ignition timing and rectify if necessary.

- 5 - Close control valve and increase speed until the vacuum reading is higher than given in the table (see 3.2/1) for the end of advance check. Move knob to "A" and let engine run on at idling speed.

- 6 - Reduce the vacuum with the control valve to the test pressure given in the table.

Direct flashes from timing light onto the timing mark and "bring the mark back" with the adjusting disc. Read off the advance in degrees on the measuring instrument.

Vacuum spark retard

- 1 - Connect tester between "retard unit" and vacuum line.
- 2 - Pull vacuum hose off "advance unit".
- 3 - Run engine at 900 rpm and direct flashes onto timing mark. (Vacuum control valve must be open.)
- 4 - Bring mark back with adjusting disc.
Read off the total spark retard on the measuring instrument (see specified figures page 3.2/1).
- 5 - Close vacuum control valve slowly. Read off vacuum figures for beginning and end of spark retard.

Vacuum spark advance

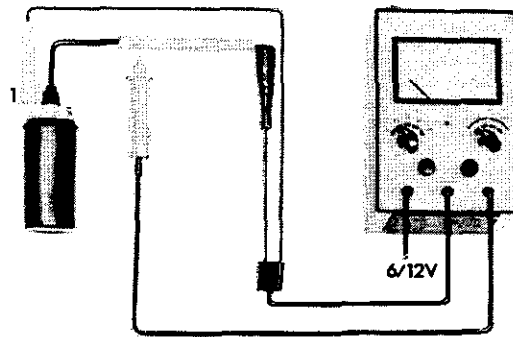
- 1 - Connect tester between "advance unit" and vacuum line.
- 2 - Pull vacuum hose off "retard unit".
- 3 - Run engine at 900 rpm and direct flashes onto timing mark. (Vacuum control valve must be open.)
- 4 - With the adjusting disc on the measuring instrument, bring back the deviation from the basic ignition timing caused by the absence of the "retard" vacuum connection. Note the reading.
- 5 - Increase speed until the vacuum reading is higher than given for the end of spark control check in table (see page 3.2/1).
- 6 - Maintain vacuum and reduce speed to 900 rpm.
- 7 - Bring mark back with adjusting disc and read off the advance. Subtract the reading noted at point 4 to obtain the vacuum spark advance.
- 8 - Open vacuum control valve slowly. Read off the vacuum figures for beginning and end of advance.

Checking coil

- 1 - Keep coil cap clean and dry to avoid shorting and tracking.
- 2 - Check that the flat terminals fit tightly to prevent voltage drop.
- 3 - Check coil output with coil tester.

The test appliance should be connected as shown in illustration and operated in accordance with manufacturer's instructions.

A resistance is connected to the high tension side of the coil (terminal 4) and a constant impulse flow fed into the coil from the test appliance. The ignition voltage given by the coil under this load is measured and should be in the order of 18,000 V (18 kV).



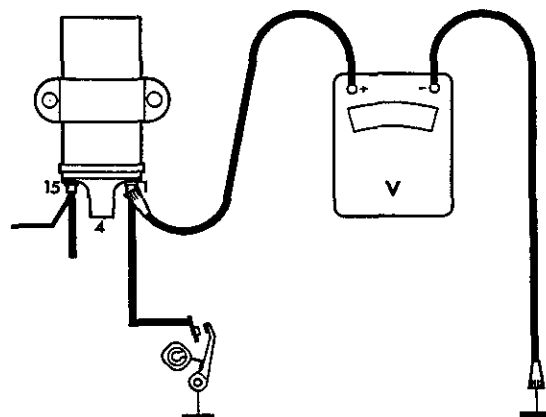
- 4 - If such a test appliance is not available, the coil can be tested as follows:

Pull the high tension cable out of the center of the distributor cap (terminal 4) and hold it about 10 mm away from a suitable ground. It is advisable to use a pair of insulated pliers for this purpose. Then turn the engine over with the starter and see if a spark jumps from cable end to ground. If there is no spark, check the voltage at terminal 15 on the coil with a voltmeter. There should be at least 9 volts at this point on a 12 volt system.

If the measured voltage is above this figure, check terminal 1 on coil (connection to distributor) with a voltmeter or test light. There should be no voltage reading at this terminal when the contacts are closed and a reading when they are open. Should there be no voltmeter reading even when contacts are open (distributor not being shorted) there is an open circuit in the coil and the coil must be replaced.

Checking contact points (electrical)

Connect voltmeter to terminal 1 on the coil and ground. Turn engine until points in distributor are closed. The meter needle should move. When points are open, meter needle should not move. If the meter needle does not move when points are closed, the points are either dirty or burned.



Checking condenser

The condenser reduces arcing when the points first open and prevents them from being burned prematurely.

A defective condenser causes badly burned points, a poor spark with starting difficulty or complete loss of ignition spark.

The condenser can be tested for short circuit with a test light:

Pull off wiring to distributor at coil (terminal 1). Connect a test light between terminal 15 on the coil and the wiring (1) on the distributor. When the points are open and ignition switched on, the lamp should not light up. If it does light, there is a short in the condenser. There are condenser testers with which it is possible to test the insulation resistance, the capacity and the series resistance of a condenser. These testers should be used in accordance with the manufacturer's instructions.

Only condensers of the prescribed type should be used as replacements as condensers with different capacities will reduce the service life of the points (see Parts List.).

Checking suppression resistances

The resistance of the copper-cored cables is too low to conform to the radio interference suppression regulations in some countries. For this reason, suppression resistances are installed in the plug connectors and in the rotor. Further resistances in the cable connectors are often installed when a radio is being installed in the vehicle.

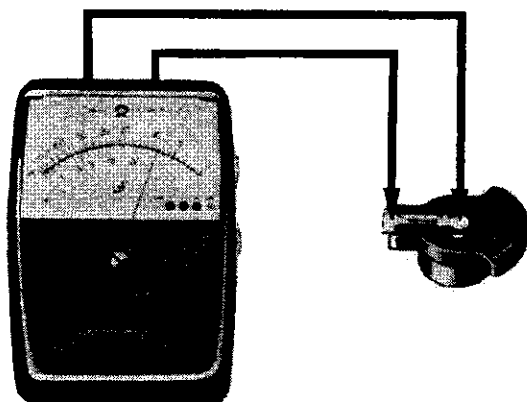
Failure of any of these resistances can cause misfiring.

- 1 - Check rotor with an ohmmeter.

The suppressed rotor has a moulded-in resistance which has a resistance value of up to 10 k Ω . If the resistance is higher, the rotor must be replaced.

- 2 - Check plug and distributor connectors with an ohmmeter.

The resistance of a plug connector or cable connector must not be more than 5–10 k Ω .

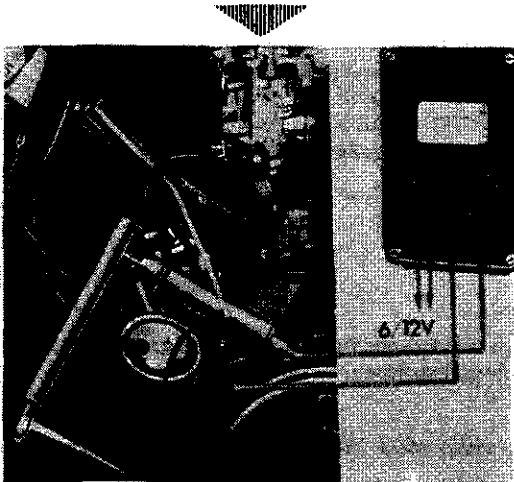


Trouble shooting

Checking coil

- 1 - Keep insulating cap clean and dry to avoid shorting and tracking.
- 2 - Check that the flat terminals fit tightly to prevent voltage drop.
- 3 - Check coil output with coil tester.

The test appliance should be connected as shown in illustration and operated in accordance with manufacturer's instructions.



Operation:

A resistance (1) is connected to the high tension side of the coil (terminal 4) and a constant impulse flow fed into the coil from the test appliance (2). The ignition voltage given by the coil under this load is measured and should be within specifications.

- 4 - If such a test appliance is not available, the coil can be tested as follows:

Pull the high tension cable out of the center of the distributor cap (terminal 4) and hold it about .4 in. (10 mm) away from a suitable ground. It is advisable to use a pair of insulated pliers for this purpose. Then turn the engine over with the starter and see if a spark jumps from cable end to ground. If there is no spark, check the voltage at terminal 15 on the coil with a voltmeter. There should be at least 9 volts at this point on a 12 volt system.

If the measured voltage is above this figure, check terminal 1 on coil (connection to distributor) with a voltmeter or test lamp. There should be no voltage reading at this terminal when the points are closed and a reading when they are open. Should there be no voltmeter reading even when points are open (distributor not being shorted) there is an open circuit in the coil and the coil must be replaced.

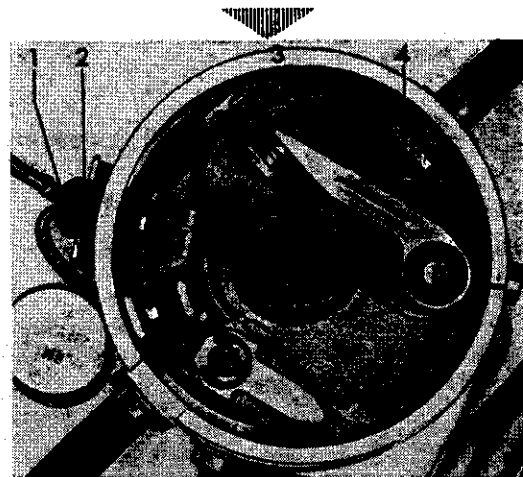
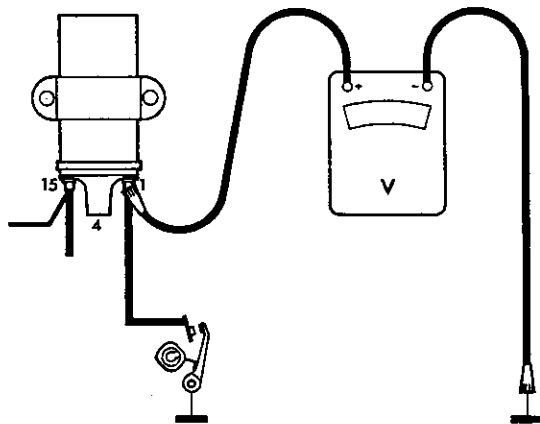
M3.3 Ignition System — Checking and Adjusting

Checking contact breaker points (electrically)

Connect voltmeter to terminal 1 on the coil and ground. Turn engine until points in distributor are closed. The meter needle should move. When the points are open, the meter needle should not move.

If the meter needle does not move when points are closed, the points are either dirty or burned.

If the meter needle moves when the points are open, there is a short circuit in the distributor. Check the following points when this happens:



- 1 - Condenser
- 2 - Cable entry
- 3 - Cable
- 4 - Insulation on breaker arm spring

Checking condenser

The condenser plays an important part to reach the high voltage necessary for the ignition system. It also reduces arcing and premature burning of the points when they open.

A defective condenser causes badly burned points, a poor spark with starting difficulty or complete loss of ignition spark.

Defective condensers are extremely rare.

The condenser can be tested for short circuit with a test lamp:

Pull cable 1 to distributor off at coil. Connect a test lamp between terminal 15 on the coil and cable 1 on the distributor. When the points are open and the ignition is switched on, the lamp should not light up. If it does light, there is a short in the condenser.

There are condenser testers that test the insulation resistance, the capacity and the series resistance of a condenser. These testers should be used in accordance with the manufacturer's instructions.

Only condensers of the prescribed type should be used as replacements. Condensers with different capacities will reduce the service life of the points (see Parts List.).

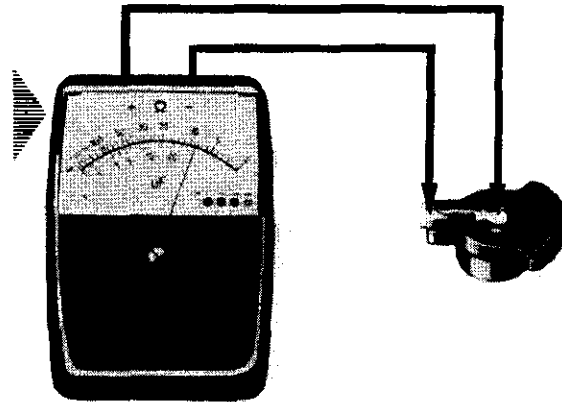
Checking suppression resistances

The resistance of the copper-cored cables is too low to conform to the radio interference suppression regulations in some countries. For this reason, suppression resistors are fitted in the plug connectors and in the rotor. In addition, there are resistors needed when a radio is installed.

Failure of any of these resistors can cause misfiring.

- 1 - Check rotor with an ohmmeter.

The suppressed rotor has a moulded-in resistor which has a resistance value of up to 10 k Ω . If the resistance is higher, the rotor must be replaced.



- 2 - Check plug and distributor connectors with an ohmmeter.

The resistance of a plug connector or cable connector must not be more than 5—10 k Ω .

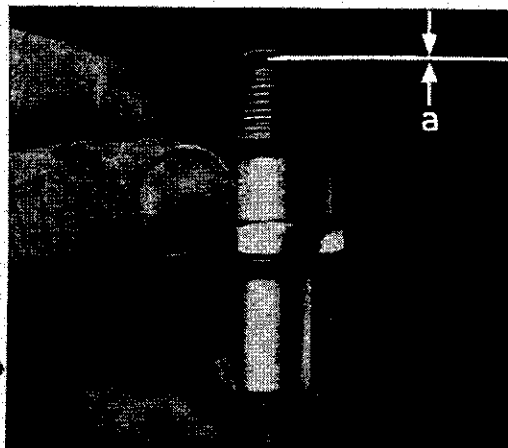
Checking ignition parts

Checking spark plugs

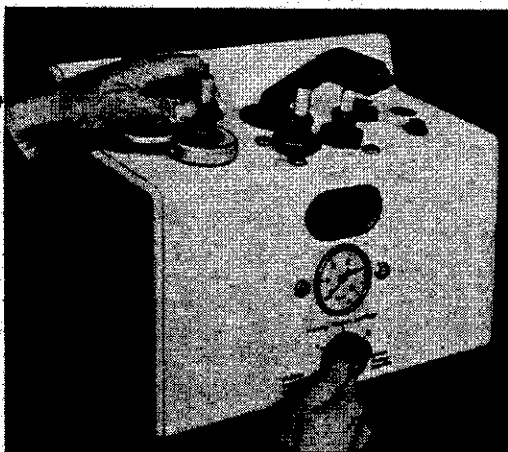
When in operation, the plug electrode gap tends to increase due to natural burning. When the gap becomes too large, the plug will start to misfire. Furthermore, dirty plugs can cause ignition and starting difficulties.

The gap is checked with a spark plug gauge and adjusted to the correct gap "a" by bending the ground electrode.

"a" = .028 in. (0.7 mm)



With a spark plug tester the plugs can be tested under a pressure of 85—114 psi (6—8 kg/cm²). The sparking can be seen through an inspection hole. The same tester can be used to clean the plugs. Older testers work on a sandblast principle while modern appliances use a special cleaning agent.



Plugs should always be cleaned with such an appliance. Steel wire brushes and other tools are unsuitable for this purpose.

Checking distributor on a test stand

On a distributor test stand, the cam offset, the vacuum advance, the centrifugal advance and the dwell angle can be checked. There are various types of test stand on the market, but they all have the following equipment in common:

Variable speed motor, tachometer, vacuum pump and a vacuum measuring gauge which must have a range of 0—100 mm Hg for distributors installed on VW engines.

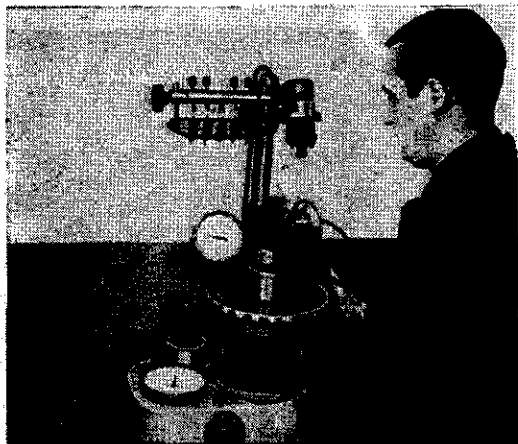
The recommended test sequence is as follows:

- 1 - Clamp distributor in position and ensure that it runs smoothly.
- 2 - Check the dwell angle (see M 3.3/1-2). It may be necessary to adjust the contact gap and thus the dwell angle.

M3.3 Ignition System — Checking and Adjusting

- 3 - Set speed to 500 rpm and note that at this speed the centrifugal advance mechanism has not started operating.

- 5 - Check vacuum unit for leakage. A vacuum of 100 mm Hg should remain constant for about 1 minute with vacuum line sealed.



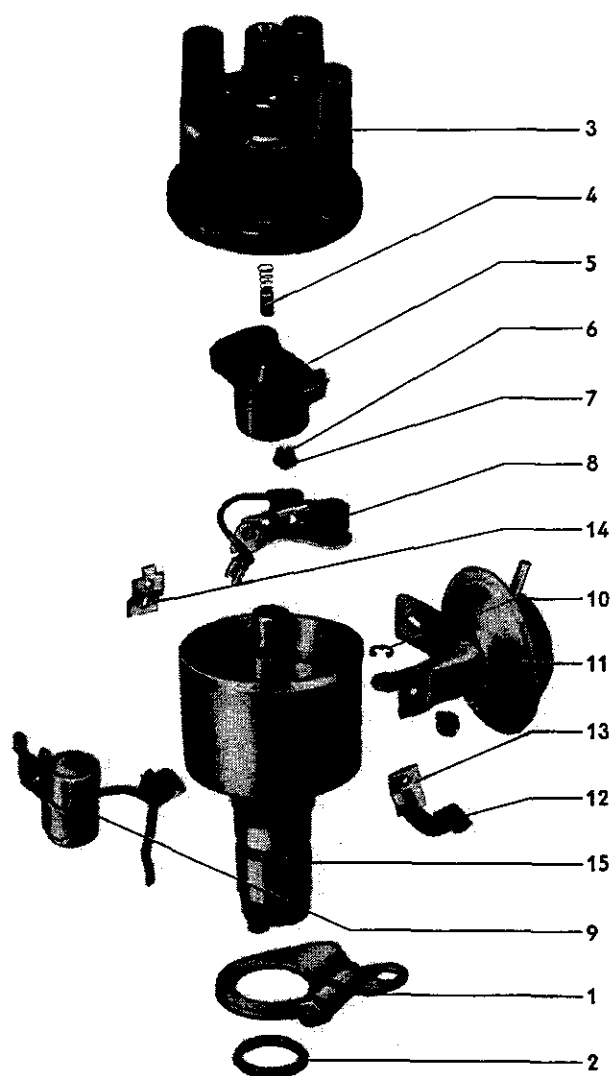
- 4 - Connect hose between vacuum pump and vacuum unit on distributor. Generate full vacuum with pump.

- 6 - With a falling vacuum, measure the vacuum advance. Check the vacuum to vacuum unit at as many points as possible and read off the actual advance figures obtained on the test stand scale. The values must be inside the shaded area of the advance curves. If they are outside this area, repeat the test with a new vacuum unit.

- 7 - Run off the speed sensitive advance curves on the test stand. These values must also be within the shaded area.

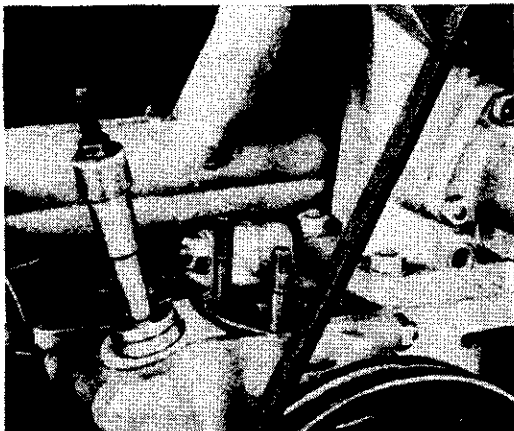


No.	Description	Special tool	Remarks
1	Extractor for starter bushing	VW 228 b	



No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Clamp	1			
2	Rubber sealing ring	1		replace	
3	Distributor cap	1		check for cracks, tracking and condition of carbon brush	
4	Carbon brush and spring	1		check correct position	
5	Rotor	1			
6	Screw	2			
7	Washer	1			
8	Contact points	1	disconnect wire remove screw	make sure that the contact points are clean and correctly adjusted. Lubricate contact pivot with one drop of oil; Lubricate cam and fiber block with multi-purpose grease.	3.3/2 3.3/1
9	Condenser	1			3.3/3
10	Clip for pull rod	1			
11	Vacuum unit	1		check for leakage	
12	Retaining clip	2			
13	Tab for retaining clip	2			
14	Tab with boss for retaining clip	2		install near cut-out in distributor body	
15	Distributor body	1		if radial play between shaft and housing is excessive, replace shaft or complete distributor.	3.4/1

M Type 1 Ignition System



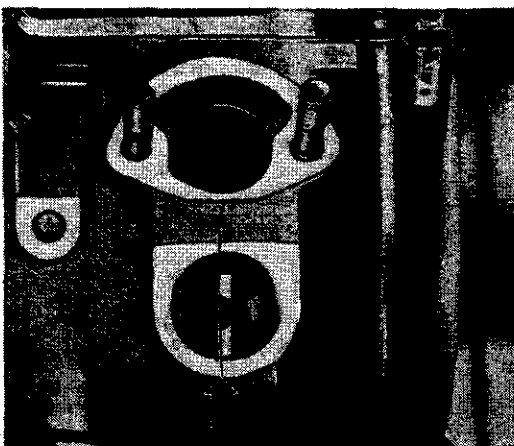
Removing and installing distributor drive shaft

1 - Withdraw drive shaft with removal tool turning shaft to left as it comes out.

2 - Remove washer under drive shaft. **Be careful not to drop it into the engine.** For removal use a magnet. If the engine is on an engine stand, turn the engine to let the washer fall out.

3 - Insert drive shaft.

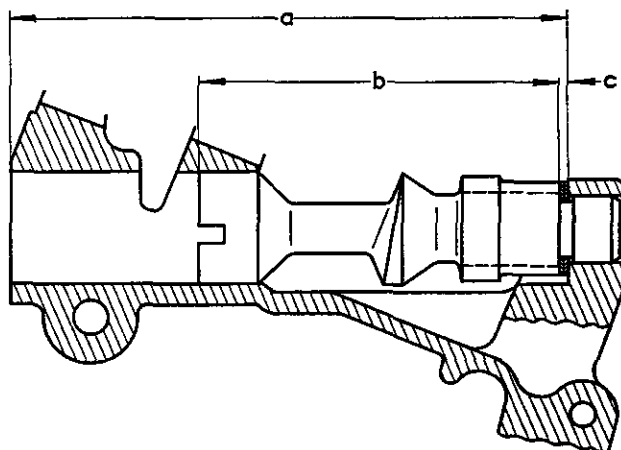
The smaller segment must face the pulley.



Note

Due to various modifications in production and reworking of the bore for the distributor drive shaft during unit reconditioning, several combinations between crankcases, distributor drive shafts and shims have resulted.

The correct pairing of parts is of importance especially for the assembly of short block engines that are supplied without distributor drive shafts and shims. Details are given in the following table:

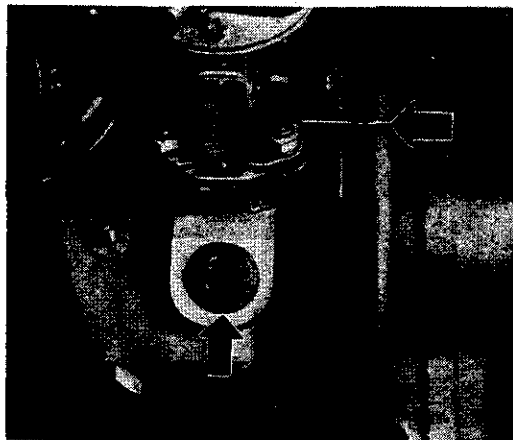


a - Depth of bore for the distributor drive shaft in mm (in.)	126.1 (4.964)	126.8 (4.991)	131.1 (5.157)	133.5 (5.255)
b - Length of distributor drive shaft up to shoulder in mm (in.)	80.3 (3.16)	80.3 (3.16)	80.3 (3.16)	85.3 (3.357)
c - Thickness of shims in mm (in.)				
upper	0.6 (0.023)	0.6 (0.023)	6.3 (0.248)	0.6 (0.023)
lower	0.6 (0.023)	1.25 (0.049)	—	3.0 (0.118)

Installing distributor

- 1 - Set No. 1 cylinder to firing point.

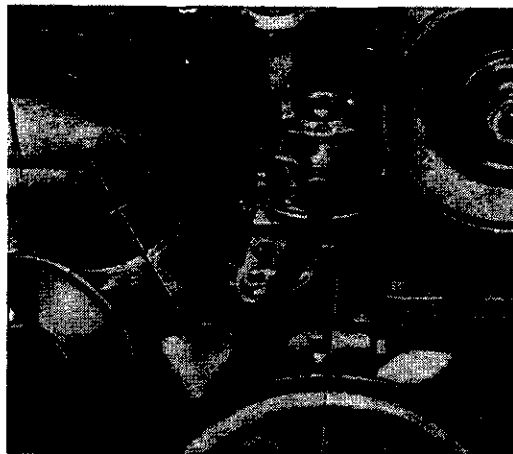
The offset slot in the distributor drive shaft must be at a **right angle** to the crankcase joint. The smaller segment must face the pulley.



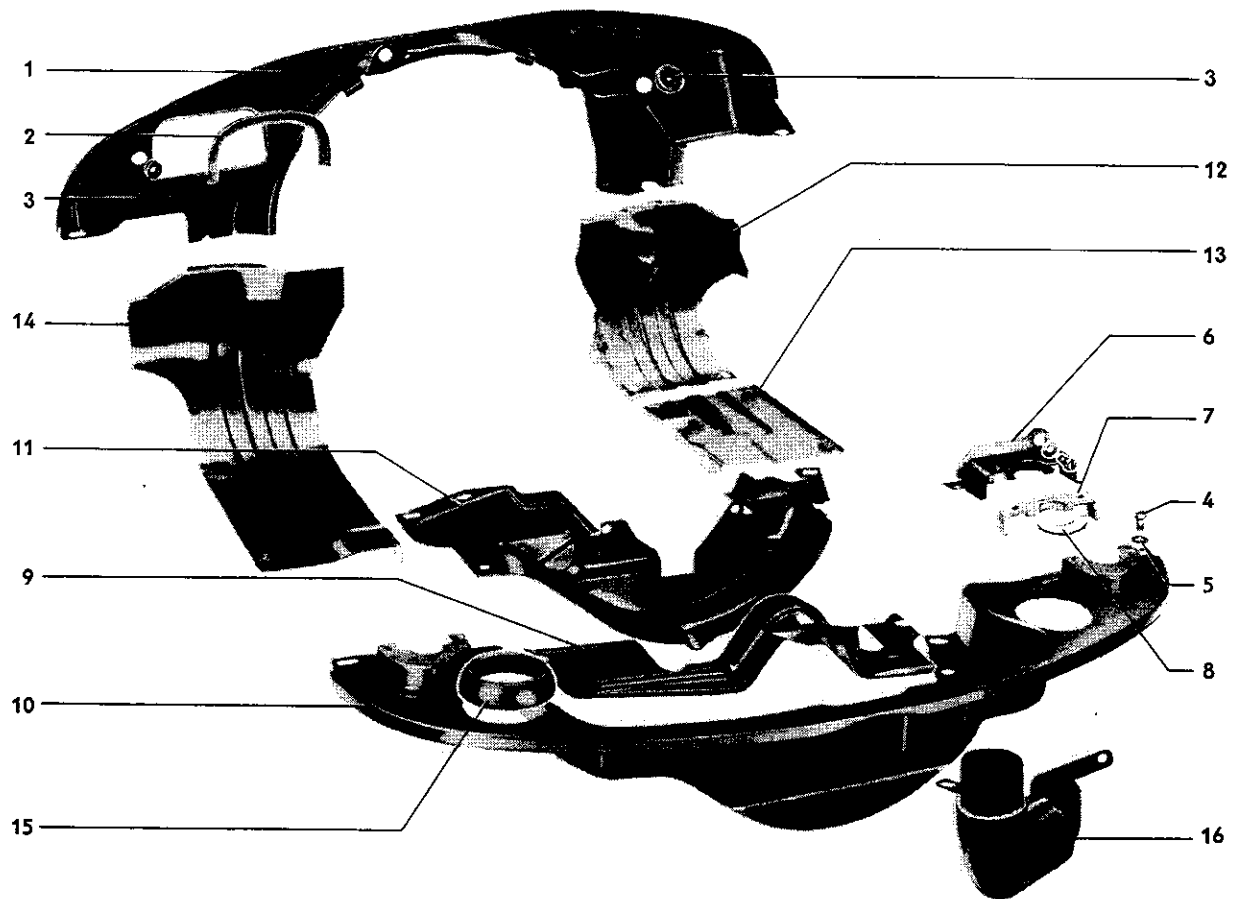
- 2 - Turn rotor in distributor until it is pointing to the No. 1 cylinder mark on distributor housing.

- 3 - Insert distributor.

- 4 - Set timing.

**Note**

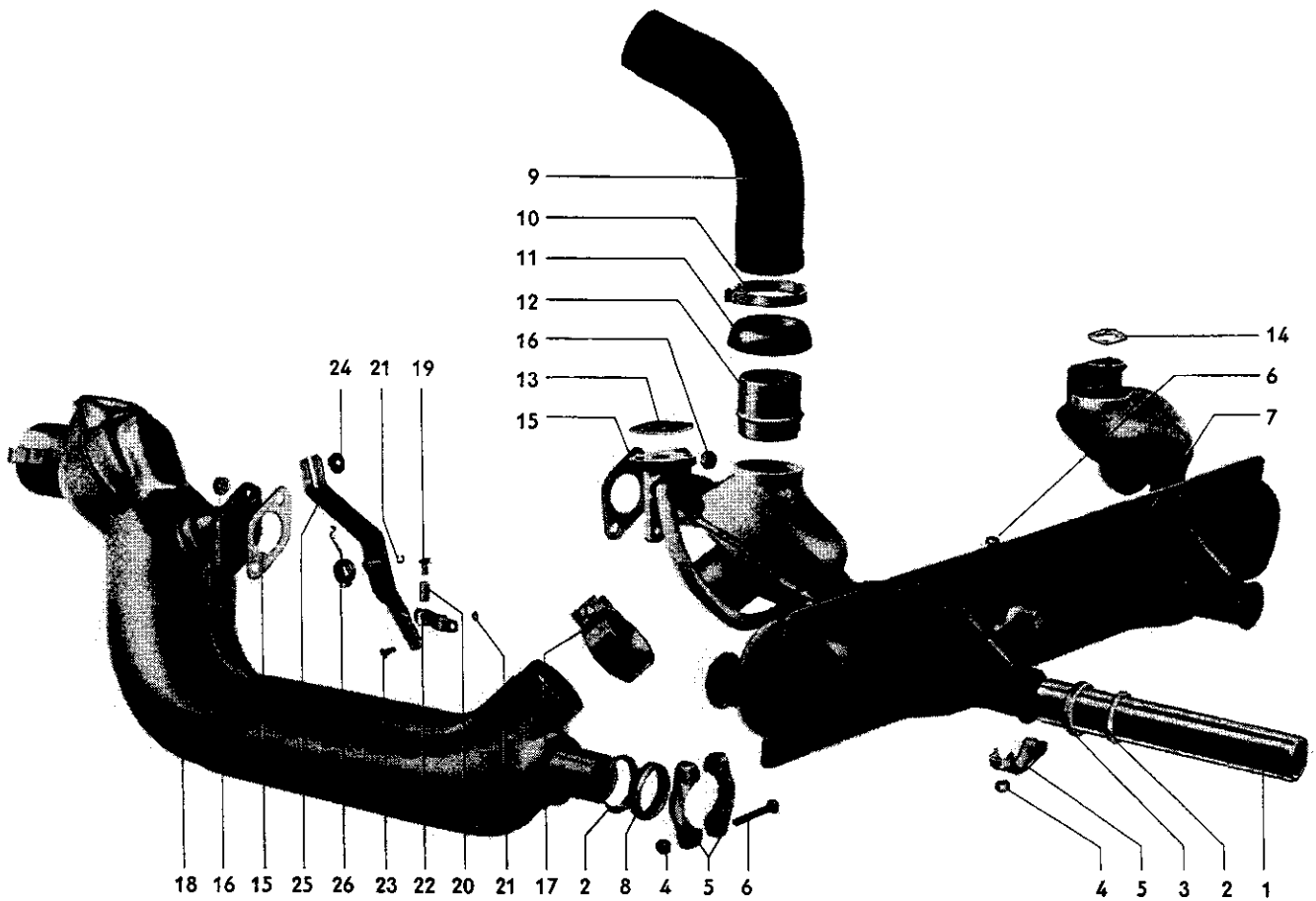
From August 1970 rubber sealing caps were installed on the plug connectors, coil and distributor due to the absence of the water drain plate in the engine compartment lid.



No.	Description	Qty.	removing		Note when installing	Special instructions see
1	Cover plate, front	1				
2	Rubber seal	1				
3	Cable grommet	2				
4	Screw M 6×10	14				
5	Washer	14				
6	Pre-heating pipe protection plate	2		right and left differ		
7	Half-round gasket, front	2			when damaged, replace	
8	Half-round gasket, rear	2			when damaged, replace	
9	Crankshaft pulley cover plate	1				only up to July 1972
10	Cover plate, rear	1				
11	Cover plate below pulley	1				
12	Warm air duct lower part, right	1				
13	Warm air duct lower part rear, right	1				
14	Warm air duct lower part, left	1				
15	Grommet for heater hose	2				
16	Elbow	1				

Carburetor preheating chart

Type	Special characteristics
1/1500, 1600 1/Automatic Stick Shift 2/1600	Warm air taken from below the right cylinder head (thermostatically controlled flap)
3/1600	Warm air taken from right heat exchanger (weight balanced flap)



No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Tail pipe	2		note insertion depth	M 4.2/2
2	Retaining ring, 35 mm dia.	4			
3	Seal, 35 mm dia.	2		replace	
4	Nut M 6 self locking	8			
5	Clamp	8			
6	Bolt M 6×43	8			
7	Muffler	1	check for leaks and damage		
8	Seal, 35 mm dia, for heat exchanger	2	marked white	replace	
9	Heater hose	2	left and right differ		
10	Hose clamp, 9 mm wide	4			
11	Heater hose grommet	2			
12	Connecting pipe	2			
13	Preheating pipe gasket (left)	1	interchangeable	replace	
14	Preheating pipe gasket (right)	1		replace	
16	Nut M 8 self blocking gasket	8		replace	
16	M 8 nut, selflocking	8		torque to 2.2 mkg (16 ft. lb.)	
17	Clamp, 25 mm wide	2			
18	Heat exchanger	2	left and right differ; check for damage; check heater flap for freeness		M 4.2/2
19	Bolt M 5×10	2			
20	Pin	2			
21	C-clip	4			
22	Link	2			
23	Pin	2			
24	Clip	2			
25	Heater flap lever	2	left and right differ		
26	Return spring	2	left and right differ		

Removing

- 1 - Bend up edges of cover plate for warm air opening and take plate off.

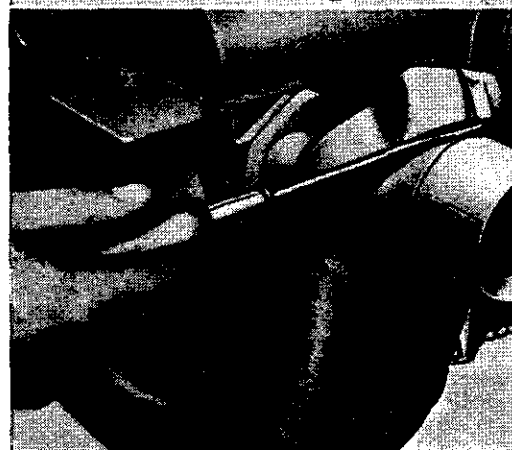
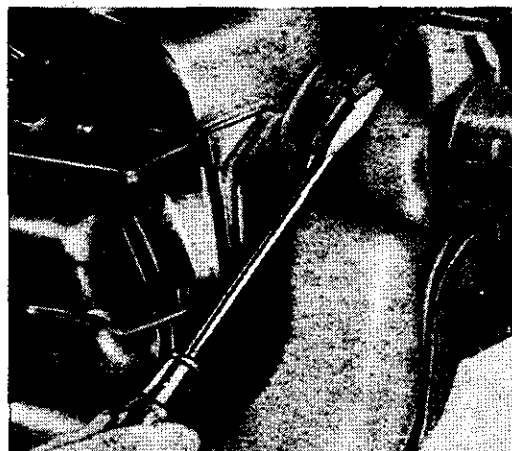
- 2 - Drill out spot welds that secure outlet pipe to heat exchanger casing with a 6 mm ($\frac{1}{4}$ in.) diameter drill.

- 3 - Bend up lip that holds heat exchanger casing together.

- 4 - Bend casing apart slightly and remove outlet pipe.

Installing

- 1 - If necessary, rework heater flap shaft hole in casing and cover plate.
- 2 - Install new outlet pipe and bend back lip of casing.
- 3 - Install cover plate and press edges together.
- 4 - Tack weld outlet pipes to heat exchanger casing. Heater flaps should be opened when doing this.
- 5 - Check flaps for freeness.
- 6 - Paint new outlet pipes with cold zinc paint.



Exhaust muffler with preheating tube in tailpipe mounting (for California only up to July 1973)

Installing

When installing the tailpipes in the muffler, it is essential to make sure that they are inserted to the correct depth.

If the tailpipes are inserted too far into the muffler there is a risk that high back pressure will be set up in the muffler and cause engine damage due to overheating.

The depth of insertion depends on the preheating pipe of the muffler (arrow).

Preheating tube, left:

first adjust the left tailpipe (see table) and then the right one accordingly.

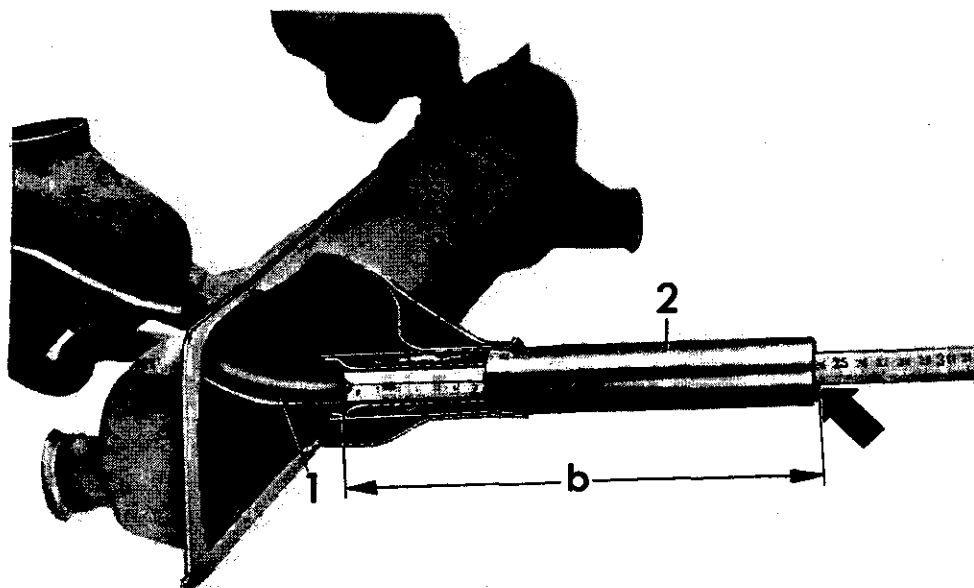
Preheating tube, right:

first adjust the right tailpipe (see table) and then the left one accordingly.

Length of tailpipe in mm (in.)	Dimension "b" in mm (in.)
276 (10 ⁷ / ₈)	270 (10 ⁵ / ₈)
249 (9 ¹³ / ₁₆)	243 (9 ⁹ / ₁₆)
226 (8 ²⁹ / ₃₂)	220 (8 ²¹ / ₃₂)

Adjust dimension "b" as follows:

Insert ruler into the tailpipe (2) so that it rests against the preheating tube (1). Then move tailpipe until the dimension "b" (see table) is obtained.



No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Pulley securing bolt	1		torque to 4.5 mkg (32.5 ft. lb.)	
2	Dished washer	1		concave side faces crankshaft	
3	Crankshaft pulley	1	pull off with VW 203 b/d	check seating and belt surfaces, clean oil return thread and oil, check for run-out	Fig. 1
4	Pulley nut	1		torque to 6 mkg (43 ft. lb.)	
5	Special washer	1			
6	Pulley half, rear	1			
7	Spacer washer	8			
8	V-belt	1	check for wear	adjust tension	M 4.3/2
9	Pulley half, front	1			
10	Woodruff key	2			
11	Generator	1			
12	Nut M 8, galvanized	1			
13	Strap	1			
14	Bolt M 8×25, galvanized	1			
15	Bolt M 6×10	4			
16	Lock washer	4			
17	Fan cover, outer	1			
18	Reinforcement flange	1			
19	Fan cover, inner	1		note installation position	M 4.3/3
20	Lock washer	2			
21	Nut M 6	2			
22	Fan hub	1			
23	Shim	3			
24	Fan	1	check for loose vanes (5 mm wider vanes, from August 1970)	gap between housing approx. 1.8 mm (0.07 in.)	M 4.3/3
25	Lock washer	1			
26	Special nut	1		torque to 6 mkg (43 ft. lb.)	
27	Fan housing	1	check for damage and loose plates		M 4.3/3
28	Washer, galvanized	2			
29	Screw M 6×10	2			
30	Return spring	1			
31	Spring	4			
32	Washer	8			
33	Cooling air regulator, left	1			
34	Cooling air regulator, right	1			
35	Cooling air regulator connecting rod	1			
36	Washer	8			

M Type 1 Cover Plates, Exhaust System, Cooling System

No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
37	Screw M 6×12	8			
38	Lock washer	1			
39	Washer	1			
40	Connecting rod	1			
41	Thermostat bracket	1		adjust	M 4.3/3
42	Thermostat	1		check in water	M 4.3/3
43	Lock washer	1			
44	Bolt M 8×15	1			
45	Lock washer	6	from August 1970		
46	Washer	6			
47	Regulating link	2			
48	Connecting rod for cooling air regulator	1			
49	Air deflector for oil cooler	1			
50	Moulded seal	1			
51	Air duct for oil cooler	1			



No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Cylinder cover plate, right	1			
2	Deflector plate, right	1			
3	Cylinder cover plate, left	1			
4	Deflector plate, left	1			

4.3 1-4 Disassembling and assembling cooling system

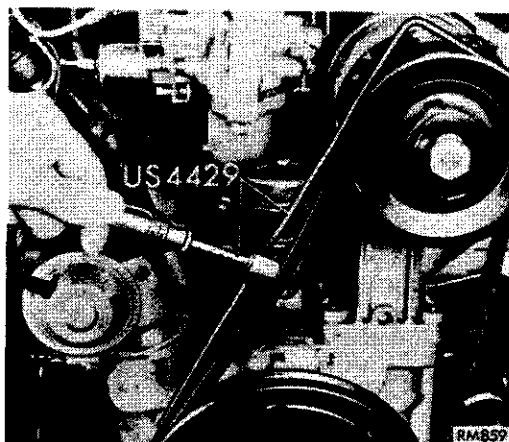
Checking

- 1 - Place holding bar on V-belt (see illustration).
- 2 - Place tension tester on top of the V-belt above the contact tongue of the holding bar.
- 3 - Apply force on tension tester until the inside of the V-belt is flush with the contact tongue.
- 4 - Read deflection force on tension tester.

The recommended deflection force is:

a) for newly installed belts = 12–14 lbs

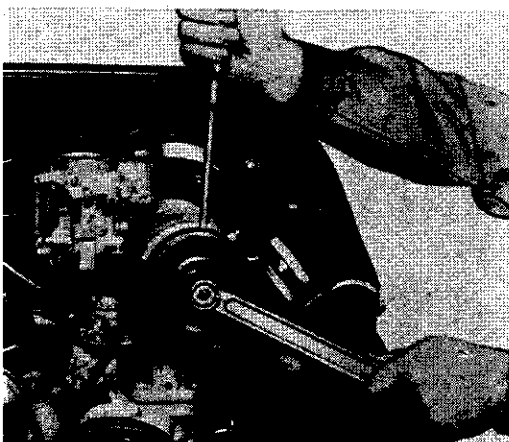
b) for used belts = 8–10 lbs
(after running more than 30 minutes).



Length of belt in mm		Remarks
900		standard
from August 1970	900 or 905	Designated DA and XDA (low stretch)

Adjusting

- 1 - Remove nut from generator shaft pulley.

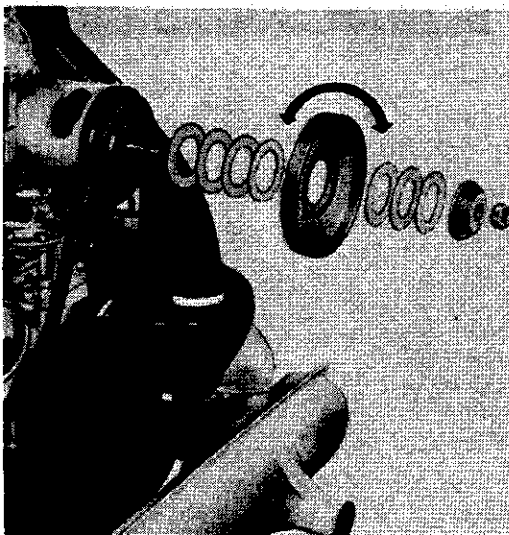


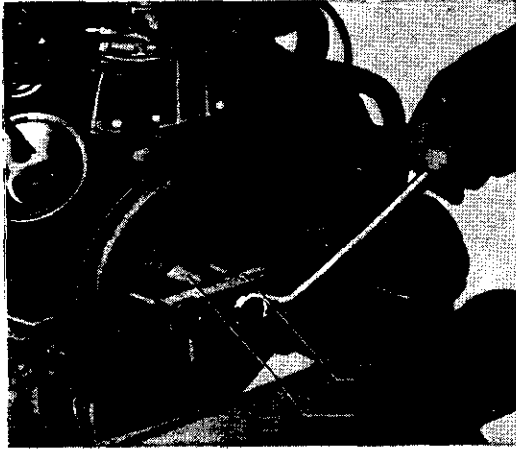
- 2 - Arrange spacer washers as required to correct belt tension.

The tension of the belt is adjusted by varying the number of washers between the pulley halves.

Adding washers loosens the belt tension and removing them tightens it.

- 3 - All the spacer washers not installed between the pulley halves should be installed between the rear pulley half and the nut so that all spacer washers are retained on pulley hub.



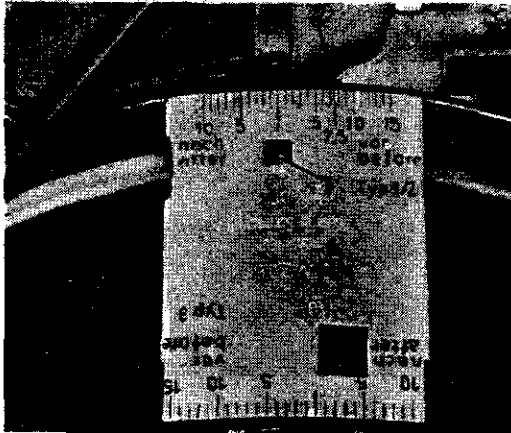


Removing crankshaft pulley

Marking ignition timing notch

From October 1971 the replacement crankshaft pulley has only the TDC mark.

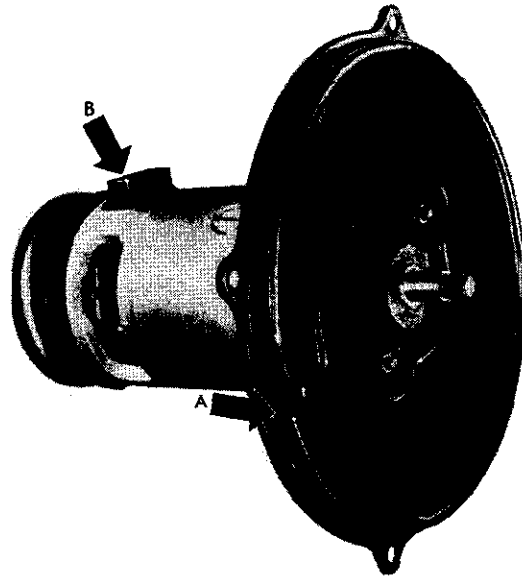
The ignition timing mark must be made when the pulley is installed, using a template and a three-cornered file.



- 1 - Place template on pulley and align square hole with the TDC mark (1).
- 2 - Make the timing mark with the aid of the template (2).
- 3 - Paint notch white.

Installing

- 1 - Assemble generator (105 mm dia.) and fan covers so that the cooling air slots of the inner cover face downward on installation in fan housing (arrow "A").



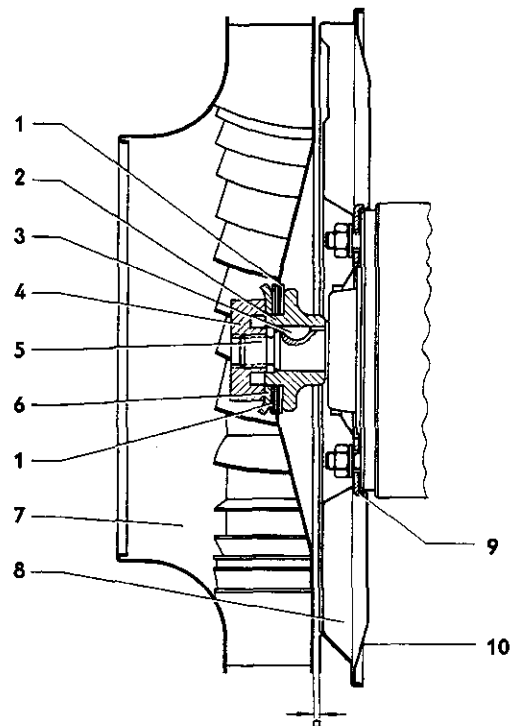
A - Cooling air slots

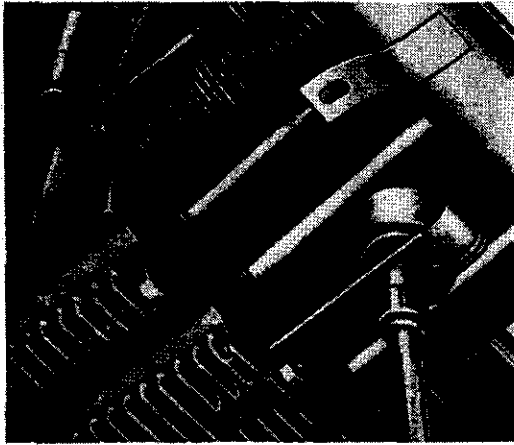
B - Connections

- 2 - Check distance of fan to cover ($a = 1.8 \text{ mm} / 0.07 \text{ in.}$). This distance is achieved by inserting spacer washers between hub and fan. Surplus washers should be installed between dished washer and fan.

$a = \text{about } 1.8 \text{ mm } (0.07 \text{ in.})$

- 1 - Spacer washers
- 2 - Hub
- 3 - Woodruff key
- 4 - Special nut
- 5 - Generator shaft
- 6 - Dished washer
- 7 - Fan
- 8 - Fan cover, inner
- 9 - Reinforcement flange
- 10 - Fan cover, outer





Removing

- 1 - Remove rear, right warm air duct lower part.
- 2 - Remove thermostat from bracket and disconnect from connecting rod.
- 3 - From August 1970.
Take off oil cooler duct and connecting rod for cooling air regulation.
- 4 - Remove fan housing.

Note

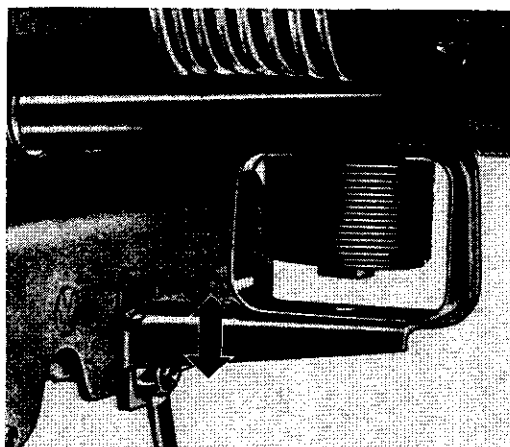
The fan housing can also be removed with the engine installed, after the rear hood has been removed.

Installing

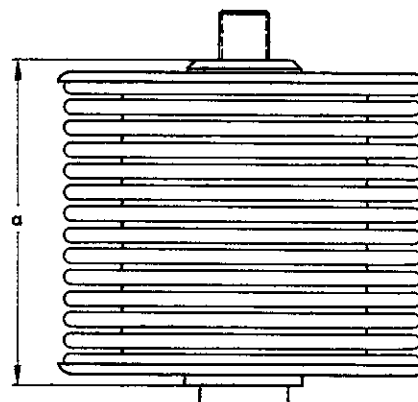
- 1 - Check fan housing for damage and loose air deflector plates.
- 2 - Insert thermostat connecting rod into hole in cylinder head and lower fan housing.
- 3 - Fan housing must fit properly on cylinder cover plates to prevent loss of cooling air. If necessary, cover plates must be bent slightly.
- 4 - Adjust throttle flaps.

Adjusting

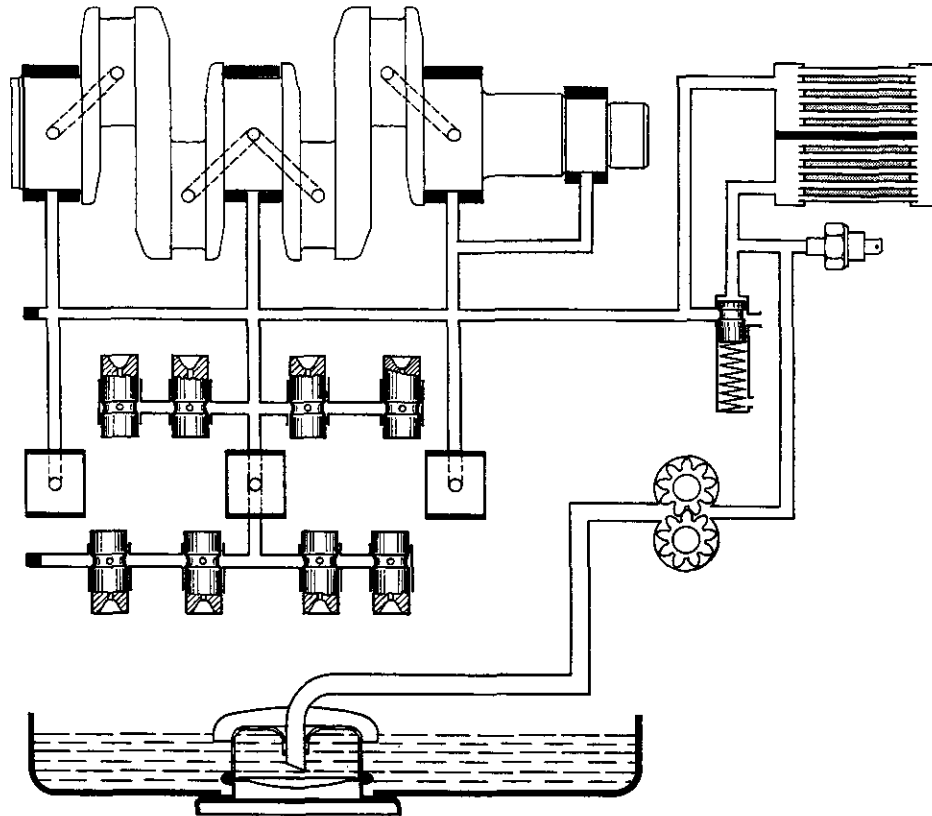
- 1 - Screw thermostat onto connecting rod.
- 2 - Loosen nut securing thermostat bracket.
- 3 - Push thermostat upward so that flaps are in open position.
- 4 - Move thermostat bracket so that thermostat contacts bracket at upper stop (arrow).
- 5 - Check operation of flaps by moving thermostat up and down.
- 6 - Secure thermostat to bracket.

**Checking thermostat**

At a temperature of 65–70° C (149–158° F) in water, the length of the unit should be at least "a" = 46 mm (1¹³/₁₆ in.).



up to July 1969

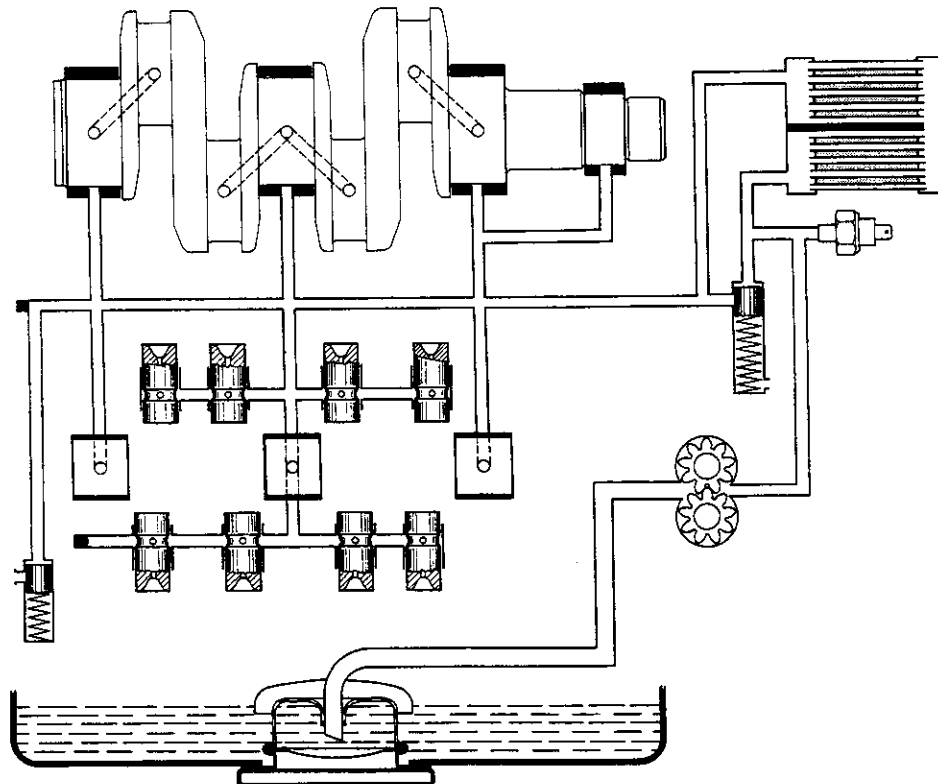


The oil pump draws oil from the crankcase through the oil strainer and pumps it through the oil cooler into the passages in the crankcase. Part of the oil passes to the main bearings and from there through drillings in the crankshaft to the connecting rod journals. A further part of the oil flows to the camshaft bearings. The remainder of the oil passes through the

hollow push rods into the drillings in the rocker arms and lubricates these bearings. Splash oil and oil mist lubricates the valve stems and then flows through the push rod tubes into the crankcase. Cylinder walls, pistons and piston pins are lubricated by splash. The oil drains down to the bottom of the crankcase from all points and is picked up by the pump to be recirculated.

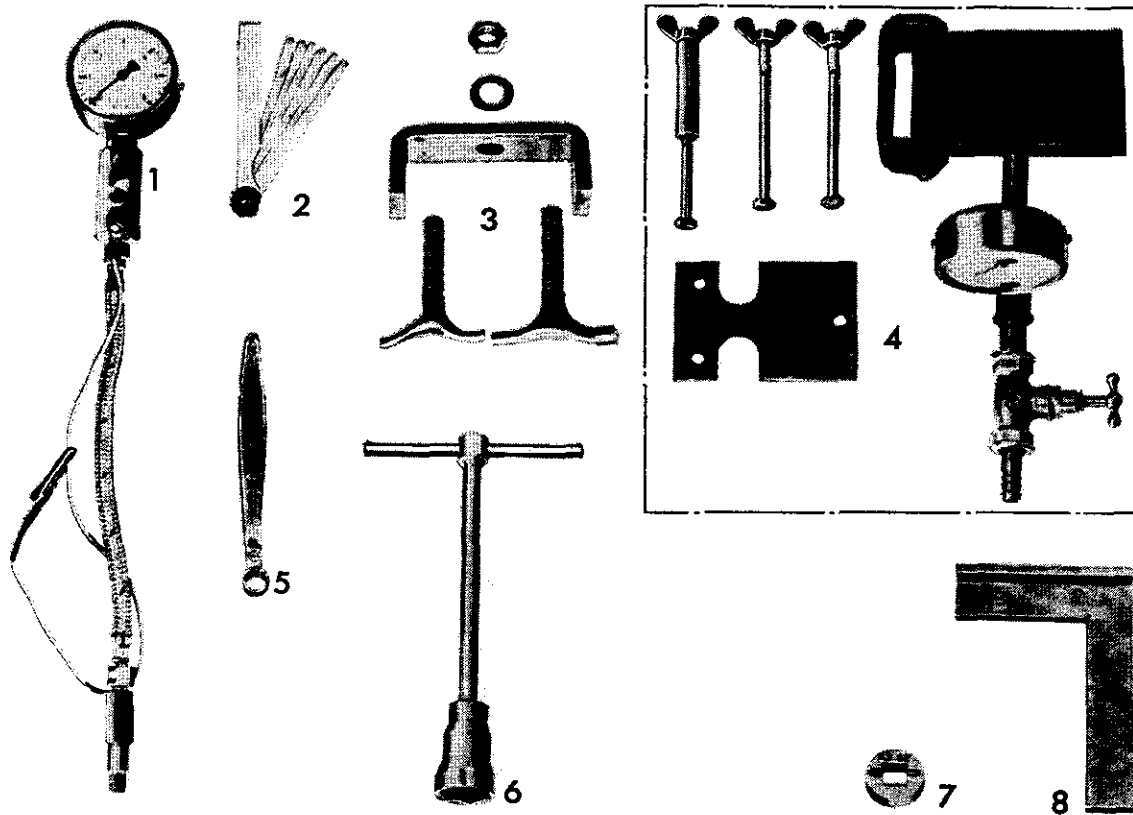
M Type 1 Lubricating System

from August 1969



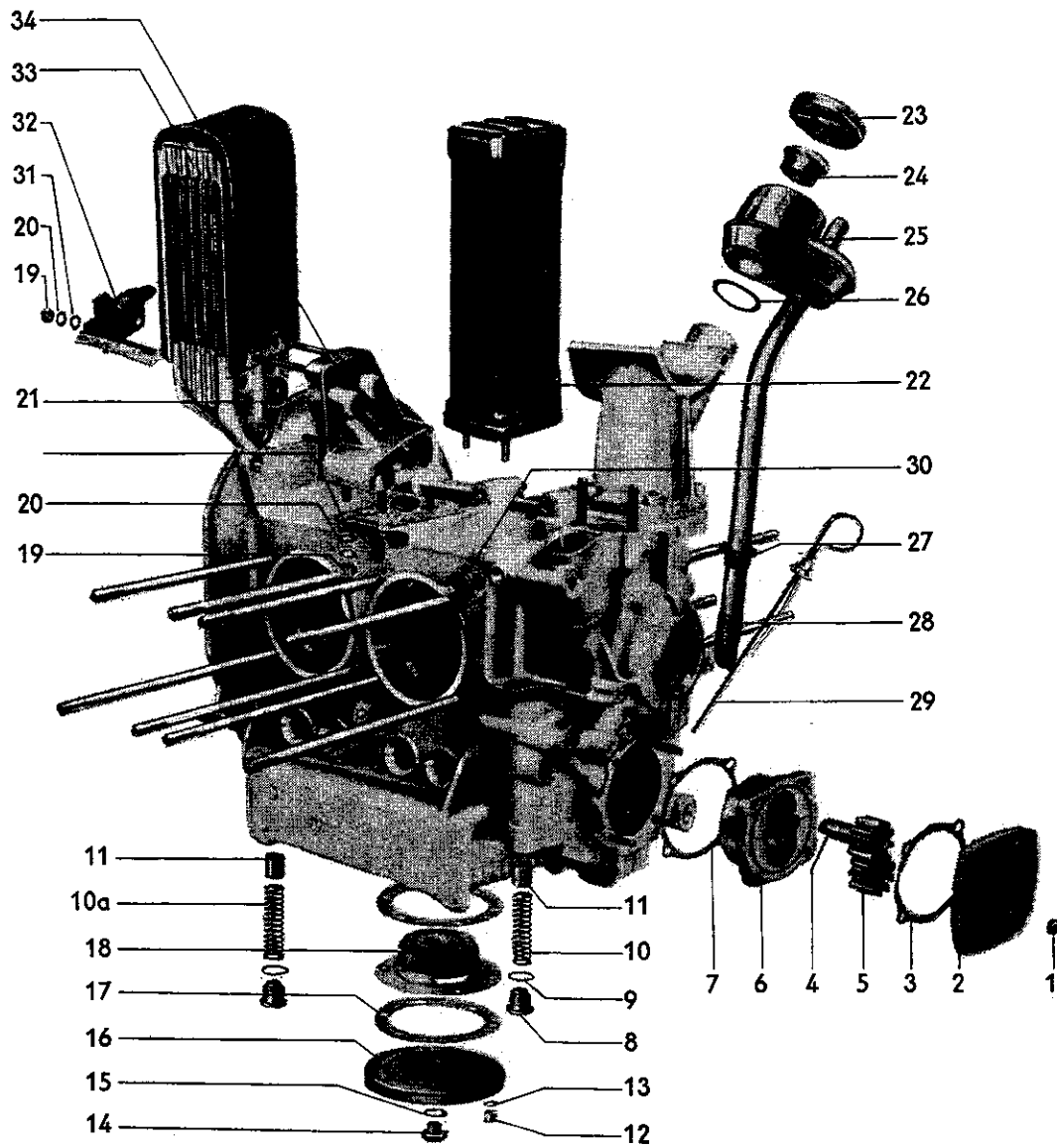
From August 1969, the engine oil system was modified by installing an oil pressure control

valve behind the main bearings. This keeps the pressure at the main bearings constant.



No.	Description	Special tool	Special instructions see
1	Oil pressure gauge, or similar	VW 662/2	
2	Feeler gauge		
3	Oil pump extractor	VW 201	
4	Oil cooler testing device	VW 661/2	
5	Box wrench, 10 mm	VW 109	
6	Oil pressure switch wrench	VW 159	
7	Socket, oil filler retaining ring	VW 170	
8	Steel square		

M Type 1 Lubricating System



No.	Description	Qty.	removing	Note when installing	Special instructions see
1	Sealing nut M 8	4		seal faces inward; tighten to 2 mkg (14 lb. ft.)	
2	Oil pump cover	1		If cover surface is scored, replace cover or grind. Note alignment of oil pump housing	
3	Oil pump cover gasket	1		replace	
4	Drive shaft	1		check for wear, axial play: max. 0.1 mm (0.004 in.) without gasket	M 5.1/3-1 Fig. 2
5	Oil pump gear	1		check for wear, backlash 0.0—0.2 mm (0.0—0.008 in.)	M 5.1/3-1
6	Oil pump housing	1	pull out with VW 201	check for wear, align to crankcase by turning the crankcase approx. 2 times	M 5.1/3-1 Fig. 1
7	Oil pump housing gasket	1		replace	
8	Plug M 18×1.5	2			
9	Seal	2		replace	
10	Spring for oil pressure relief valve	1		check for tension, length under load of: 5.6—7.3 kg = 44.1 mm (12.3—16.0 lbs. = 1.73 in.)	
10a	Spring for oil pressure control valve	1		check for tension, length under load of: 3.1—3.8 kg = 20.2 mm (6.8—8.4 lbs. = 0.795 in.)	
11	Piston for oil pressure relief and control valve	2		check for wear	
12	Cap nut M 6	6			
13	Seal	6		replace	
14	Oil drain plug	1	} discontinued from August 1972	tighten to 3.5 mkg (25 lb. ft.)	
15	Seal	1		replace	
16	Oil strainer cover	1	from August 1972 without drain plug	sealing surface must be flat	
17	Gasket	2		replace	
18	Oil strainer	1		clean	
19	Nut M 6	3			
20	Spring washer	3			
21	Oil cooler seal	2		replace	

M Type 1 Lubrication System

No.	Description	Qty.	removing	Note when installing	Special instructions see
22	Oil cooler	1	on installed engines remove and install with box wrench VW 109; check for damage and leaks with VW 661/3 at a pressure of 6 kg/cm ² (85 psi)		Fig. 3 Fig. 5
23	Oil filler neck cap	1			
24	Retaining nut for breather	1	use socket VW 170	tighten to 5.5 mkg (40 ft. lbs.)	Fig. 6
25	Oil filler and breather	1	from August 1972 the breather pipe and the breather rubber valve have been discontinued		
26	Seal	1		replace	
27	Grommet	1			
28	Breather rubber valve	1		check for damage, button must engage	
29	Dipstick	1			
30	Oil pressure switch	1		tighten to 1 mkg (7 lb. ft.)	M 5.1/4-1
31	Washer	6			
32	Sealing frame	1			
33	Oil cooler	1	from August 1970 instructions as under No. 22		Fig. 4 Fig. 5
34	Mounting flange	1			

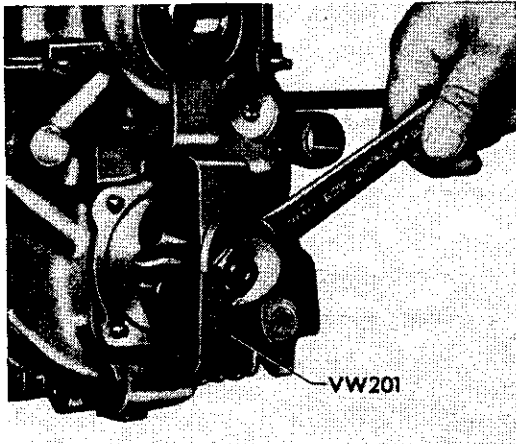


Fig. 1

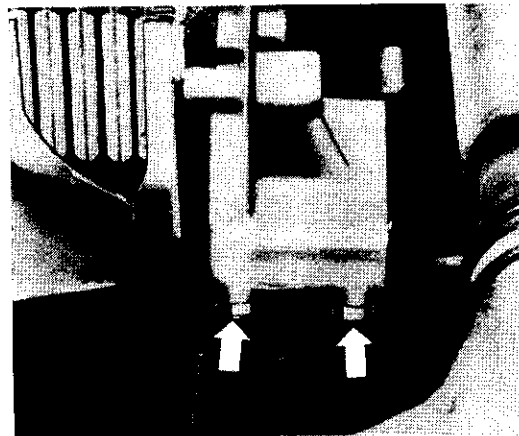


Fig. 4



Fig. 2

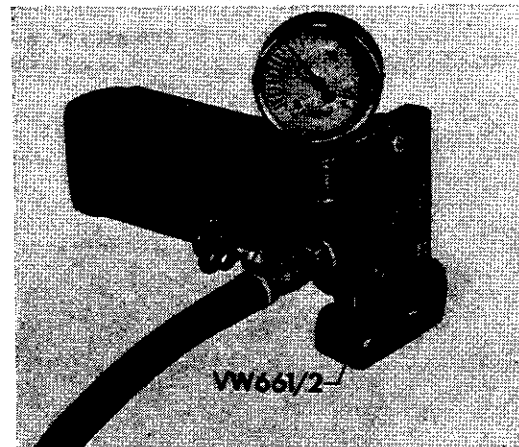


Fig. 5



Fig. 3

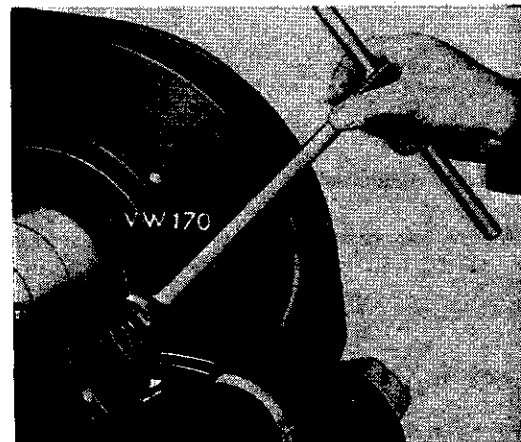
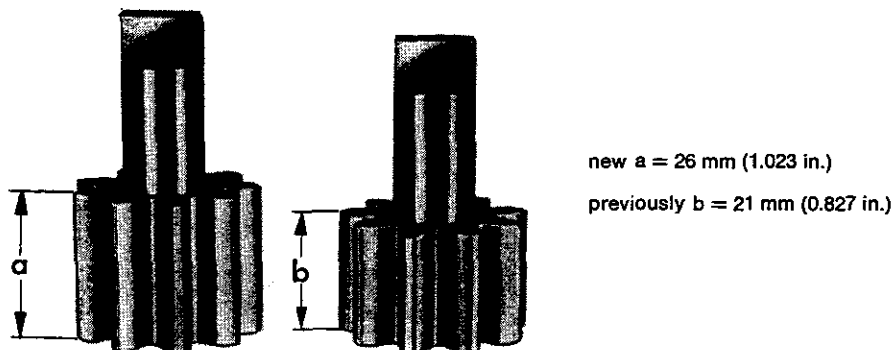
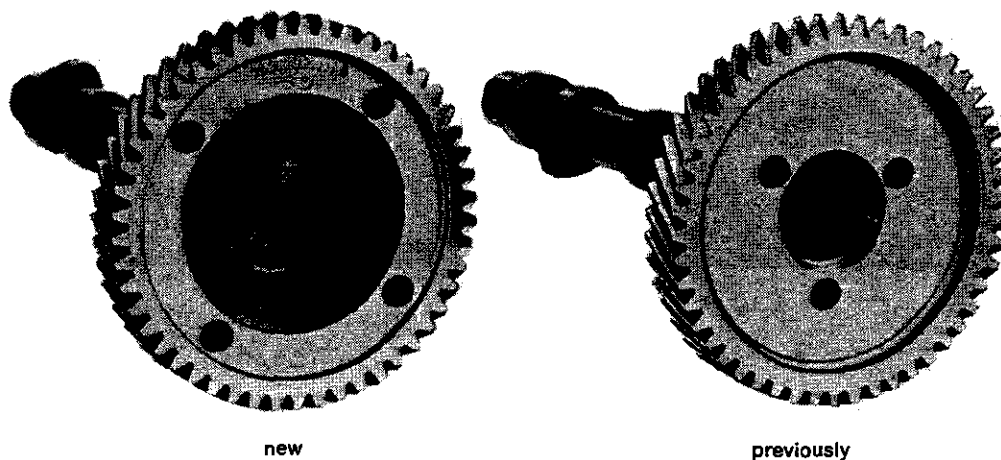


Fig. 6

To increase the delivery capacity of the oil pump, gears with wider teeth were installed from April 1971.



The oil pump housing has been widened to suit the new gears. A new camshaft with a deeper slot for the oil pump drive is used. The gear on the new camshaft is secured with 4 rivets. It can be easily identified as the previous gear was secured with 3 rivets.

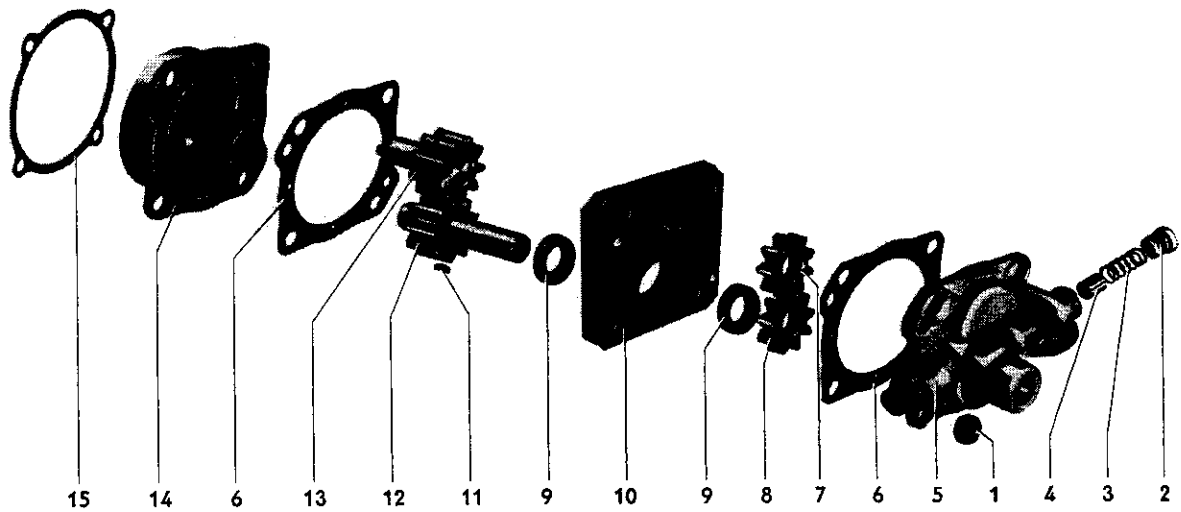


Service installation

All the new spare parts must be used when installing in earlier engines.

Caution

An old type oil pump cannot be installed in an engine with new camshaft because the oil pump drive shaft does not engage properly in the camshaft slot.



1 - Sealing nut M 8

2 - Plug

3 - Spring

4 - Piston

5 - Cover

6 - Gasket for intermediate plate and cover

7 - Outer, upper gear

8 - Outer, lower gear

9 - Oil seal for plate

10 - Intermediate plate

11 - Woodruff key

12 - Lower shaft with inner gear

13 - Upper shaft with inner gear

14 - Oil pump housing

15 - Gasket for housing

Removing

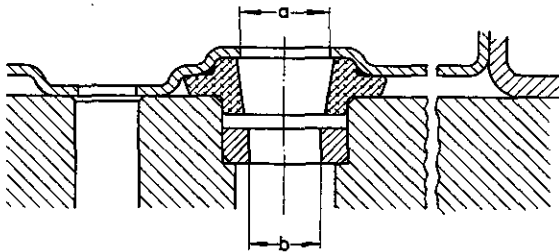
To avoid damage to the seals in the intermediate plate, remove Woodruff keys before withdrawing plate.

Checking

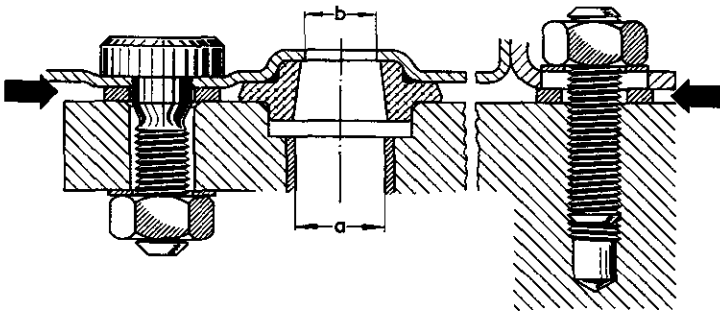
Replace the complete pump if the oil pump housing, the intermediate plate or the pump cover is damaged. Gaskets and seals can be replaced if the pump is leaking.

Oil passages in oil cooler and crankcases up to July 1969: $b = 8 \text{ mm}$ ($5/16 \text{ in.}$) diameter
from August 1969: $a = 10$ or 12 mm ($3/8$ or $15/32 \text{ in.}$) diameter.

When assembling a new oil cooler or crankcase with parts of the previous type, install **green** seals for the oil cooler and spacer washers, if necessary, as shown in the illustrations. The parts are contained in SP set – 111 198 029.



New oil cooler installed on previous type crankcase.



Previous type oil cooler installed on new type crankcase.

Install the 3 washers – N 11 533 2 – supplied in SP set (see arrows).

Note

From August 1970 the oil cooler was moved forward by installing a light alloy mounting flange. The flange is bolted to the crankcase with 8 mm bolts and the oil drillings are sealed with the usual rubber sealing rings.

Only the new crankcase will be supplied as a spare part.

When replacing the crankcase of an older engine (manufactured before August 1970), a stepped M 8/M 6 stud must be used to secure the oil cooler. To centralize the cooler, a bushing – 113 101 145 A – must be installed in one of the holes.

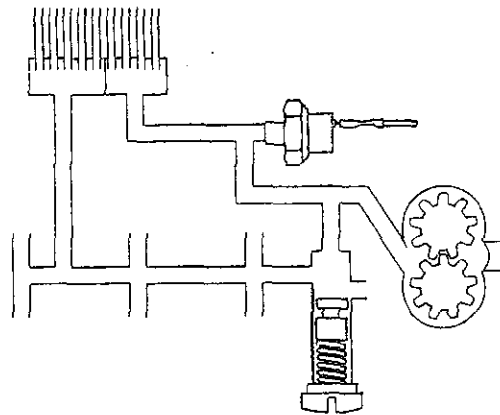
The flow of oil through the oil cooler is regulated by the oil pressure relief valve as follows:

a - Oil is thick and cold:

Oil pressure is high.

Piston is in lowest position.

Oil flows directly to the bearings and part goes back into the crankcase.

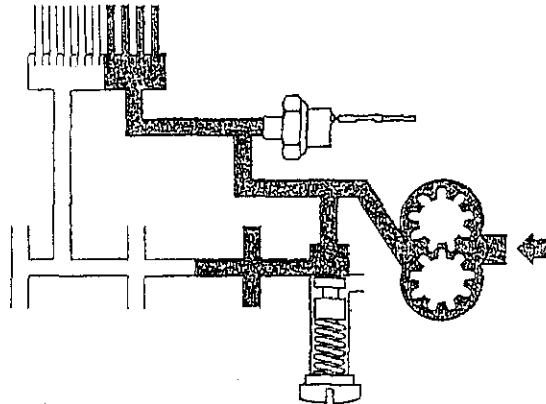


b - The oil warms up and starts to thin out:

Oil pressure drops.

Piston closes the return port.

Oil flows directly to bearings and through the oil cooler to bearings.

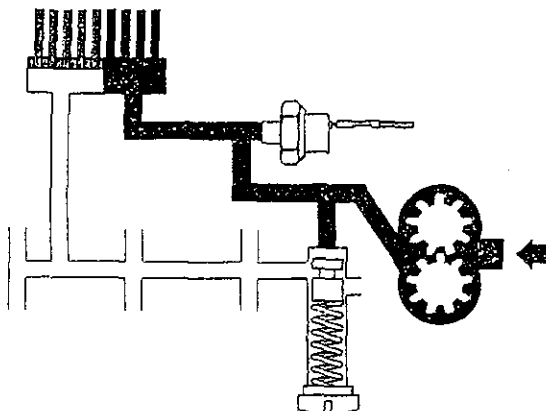


c - Oil is at operating temperature and is thin:

Oil pressure is low.

Piston is in highest position.

All oil has to pass through the oil cooler to the bearings.



Note

From August 1989 the oil pressure is kept constant by the oil pressure control valve located at the end of the system (see M 5.1/1-2).

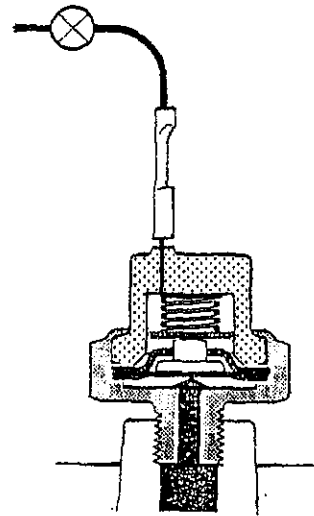
The oil pressure switch indicates the oil pressure in the engine. It is located in the oil pressure line between oil pump and oil cooler. When the engine is not running, the contact on the diaphragm is held closed by spring pressure. When the ignition is switched on, the battery current flows from terminal 15 of the starter switch via the red warning lamp and the oil pressure switch to ground. The red warning lamp lights up.

When the engine is running, the oil pressure actuates the diaphragm, opens the contact and the red warning lamp goes out.

a - Pressure rises when engine is started:

Contact opens 0.15–0.45 kg/cm² (2–6 psi);

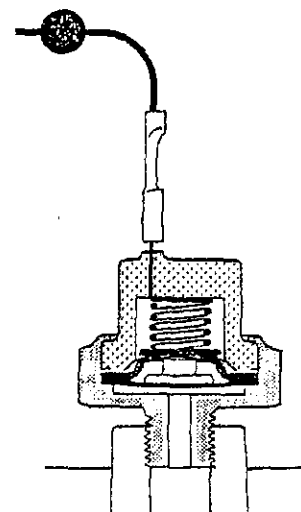
Warning lamp goes out.



b - Pressure is too low when engine is running:

Contact closes;

Warning lamp lights up.



Installing

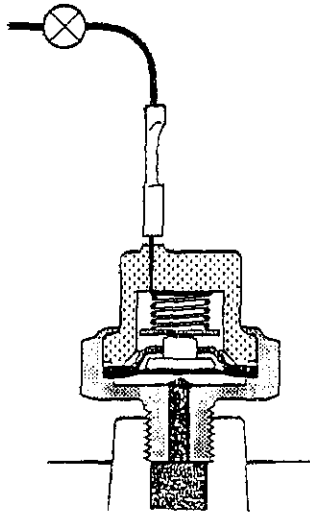
1 - Sealing is effected by the tapered thread.

To avoid damaging the thread, do not use excessive force when tightening the switch.

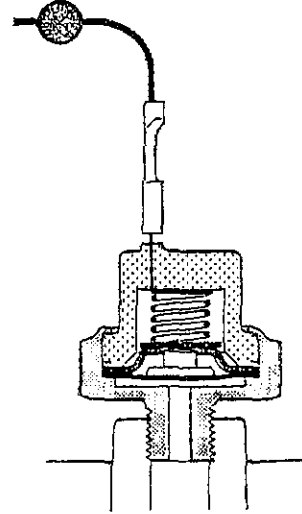
Oil pressure switch

The oil pressure switch indicates the minimum oil pressure in the engine. It is located in the oil pressure line between oil pump and oil cooler. When the engine is not running, the contact on the diaphragm is held closed by spring pressure. When the ignition is switched on, the battery current flows from terminal 15 of the starter switch via the red warning lamp and the oil pressure switch to ground. The red warning lamp lights up.

When the engine is running, the oil pressure actuates the diaphragm, opens the contact and the red warning lamp goes out.



- a - Pressure rises when engine is started:
Contact opens (2—6 psi/0.15—0.45 kg/cm²)
Warning lamp goes out.

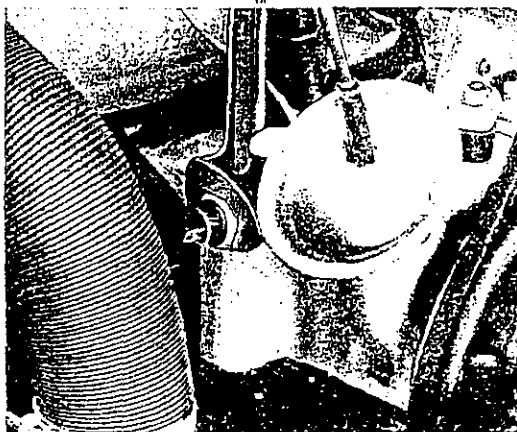


- b - Pressure is too low when engine is running:
Contact closes
Warning lamp lights up.

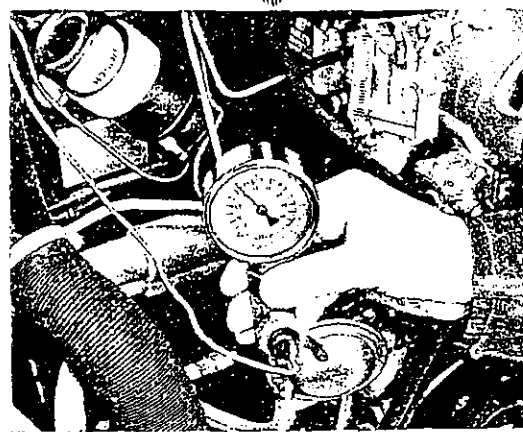
Testing

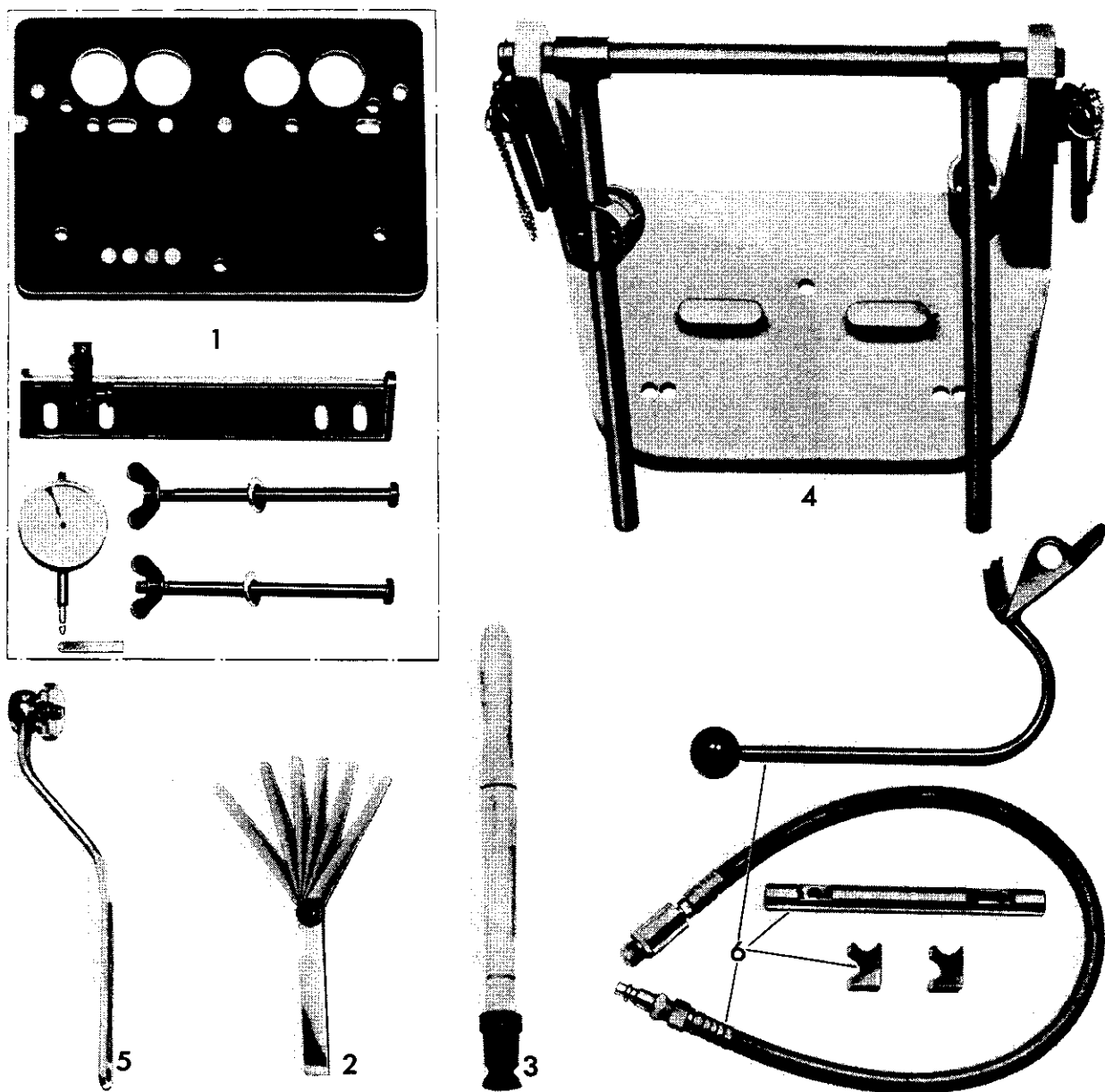
The oil pressure switch can be tested on the engine, using a simple testing device with gauge VW 622/2 and a test lamp, after the engine oil is at operating temperature.

- 1 - Remove oil pressure switch and screw it into testing device.



- 2 - Screw testing device into seat for oil pressure switch on crankcase and connect test lamp to oil pressure switch and to terminal 15 of ignition coil. When the ignition is switched on, the test lamp should light up. If the lamp does not light up, the switch is defective and must be replaced.

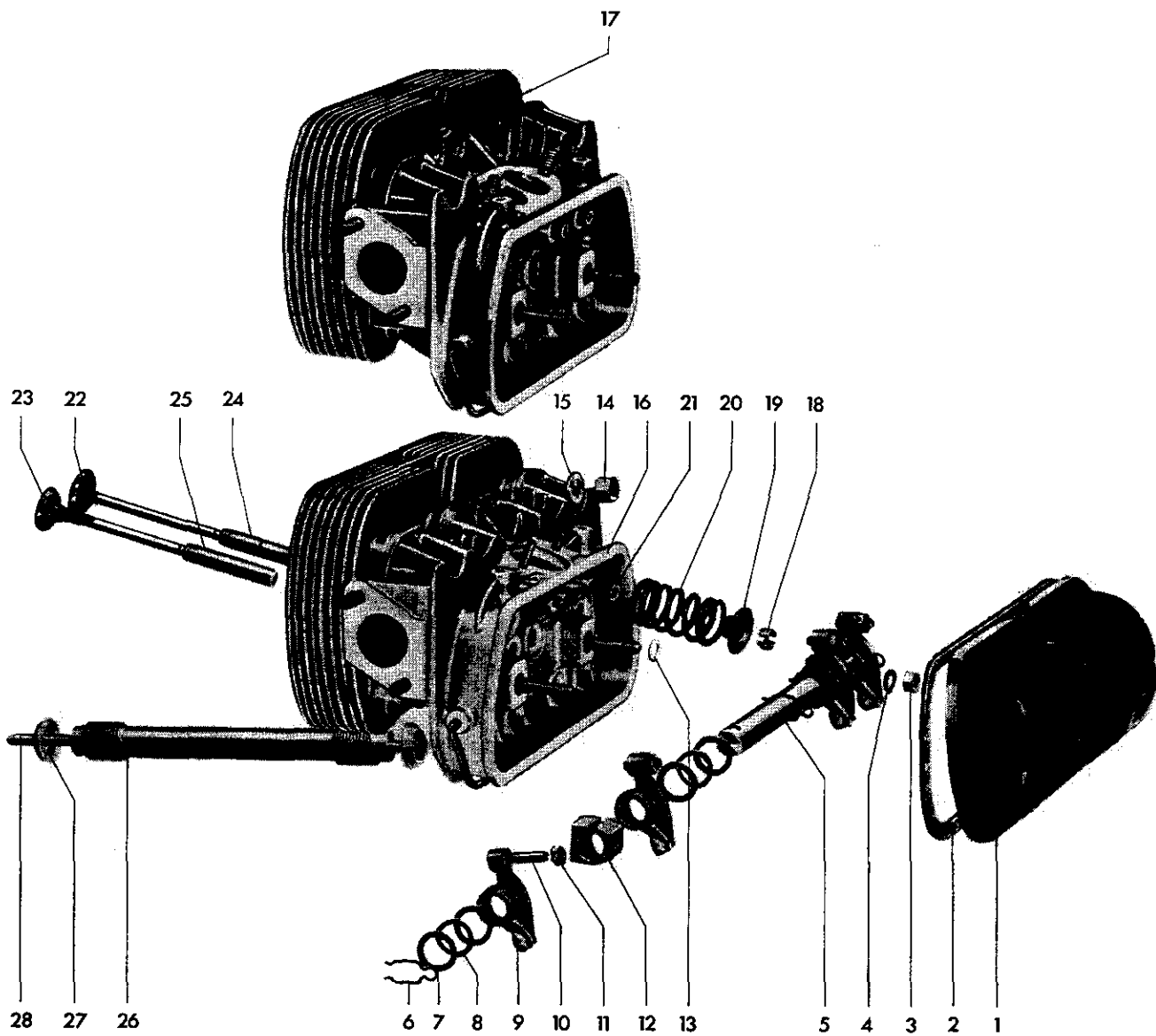




No.	Description	Special tool	Remarks
1	Valve guide wear measuring appliance	US 4420	
2	Feeler gauge		
3	Valve grinding tool		
4	Valve extractor	VW 311 h	
5	Valve clearance adjusting tool		
6	Valve spring compressor	VW 653/2	

M

Type 1 Cylinder Head and Valves, Cylinders and Pistons



No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Cylinder head cover	2			
2	Gasket for cylinder head cover	2		replace if damaged or leaking	
3	Nut, M 8×1.25	4		copper plated tighten to 18 lb. ft. 2.5 mkg	
4	Spring washer	4			
5	Rocker shaft	2		check for wear and grooves 17.97–17.99 mm (0.7073–0.7081 in.) diameter wear limit: 17.95 mm (0.7065 in.) diameter	
6	Clip	8			
7	Thrust washer	16			
8	Spring washer	8			
9	Rocker arm	8		check for wear and grooving 18.00–18.02 mm (0.7086–0.7088 in.) diameter wear limit: 18.04 mm (0.7090 in.) diameter	
10	Adjusting screw	8		check for easy turning	
11	Nut, M 8×1	8		check for easy turning	
12	Support	8		check for wear slot must face upward	Fig. 8
13	Seal for stud	4		replace	
14	Nut, M 10	16		note tightening sequence, tighten to 3.2 mkg (23 lb. ft.)	Fig. 6 Fig. 7
15	Washer	16			
16	Cylinder head	2	check cylinder heads for cracks in combustion chambers and exhaust ports and for signs of leakage on cylinder contact surfaces. Check spark plug thread and studs for damage and tightness. If necessary, fit Heli-Coil inserts. when installing cylinder head, make sure that oil seals at ends of push rod tubes are properly seated.		M 6.1/3-4
17	Cylinder head	2	from August 1970 twin intake port		
18	Valve cotter	16		replace if clearance too large	
19	Spring cap	8			
20	Valve spring	8		check valve spring tension Length loaded: 31.0 mm (1.22 in.) Load: 53.2–61.2 kg (117.2–134.8 lb.) Small end of spring faces cylinder head.	Fig. 3
21	Oil deflector ring	8		replace	
22	Intake valve	4	} use VW 311 h;	check valve seats for wear.	Fig. 1
23	Exhaust valve	4		Reface, intake valves only with a valve refacing machine to seat width d = max. 0.5 mm (0.02 in.). Reface exhaust valves by grinding only.	Fig. 2 Fig. 4
24	Intake valve guide	4	} check with measuring device VW 689/1		M 6.1/3-1
25	Exhaust valve guide	4			
26	Push rod tube	8		pretension, seam faces upward	Fig. 5
27	Sealing ring	8		replace	
28	Push rod	8		check for run-out max. 0.3 mm (0.012 in.)	M 6.1/2-1

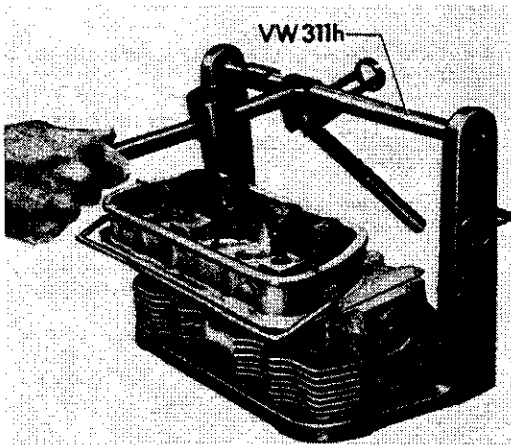


Fig. 1

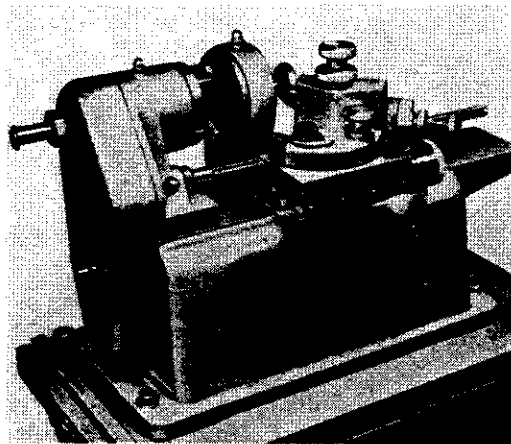


Fig. 2

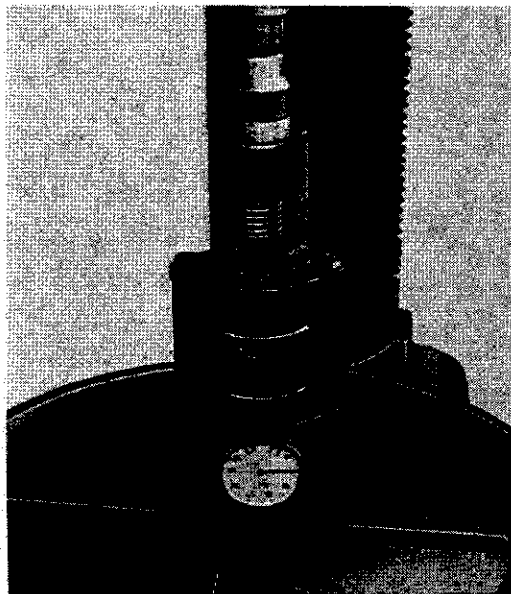


Fig. 3

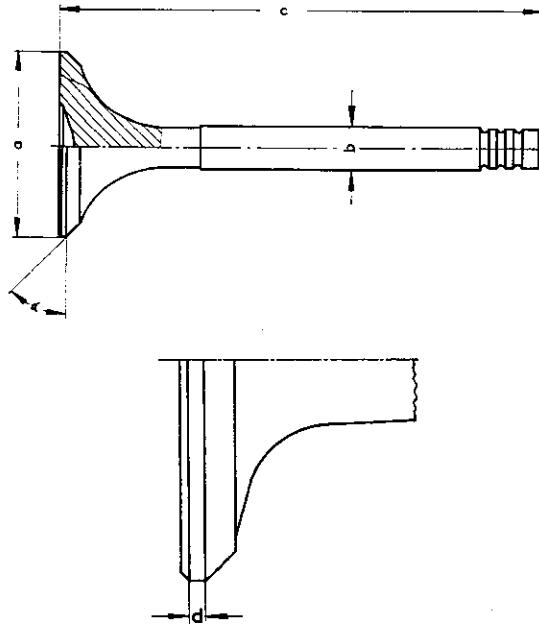
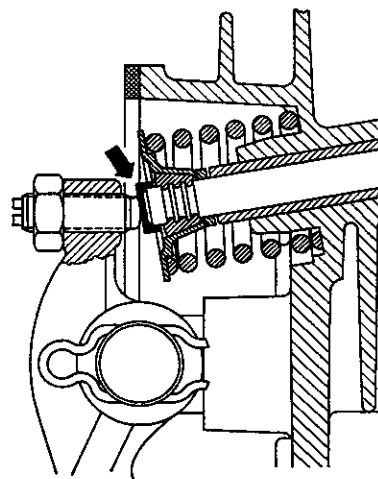


Fig. 4

	Intake valve	Exhaust valve
a	35.6 mm (1.301 in.) diameter	32.1 mm (1.263 in.) diameter
b	7.94–7.95 mm (0.312–0.313 in.) diameter	7.92–7.94 mm (0.312–0.313 in.) diameter
c	112 mm (4.4 in.)	112 mm (4.4 in.)
α	44°	45°

Note

Valves with worn stem ends can be used again by installing caps (113 109 621) on the stems (arrow). The caps are placed on the stems before the rocker arms are installed.

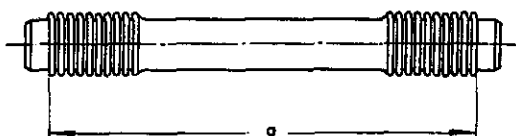


Fig. 5 a = 190—191 mm (7.4—7.52 in.)

Note

The cylinder head reconditioning system in the factory is being changed.

Only 1.0 mm (0.04 in.) thick **steel** shims are installed in exchange engines. This shim will not be available as a spare part.

For manufacturing reasons, steel shims are only produced in one thickness — 1 mm (0.04 in.).

For repairs on earlier engines, aluminium shims of thicknesses 0.8, 1.0 and 1.5 mm (0.03, 0.04 and 0.06 in.) will remain available as spare parts.

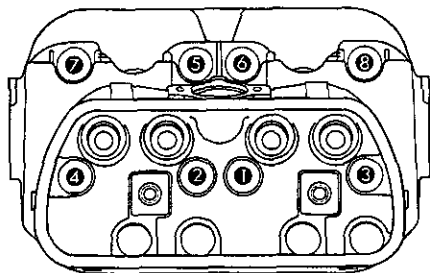


Fig. 6 Preliminary tightening sequence

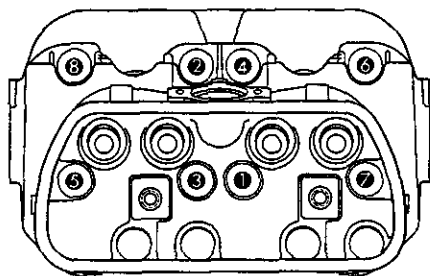


Fig. 7 Final tightening sequence

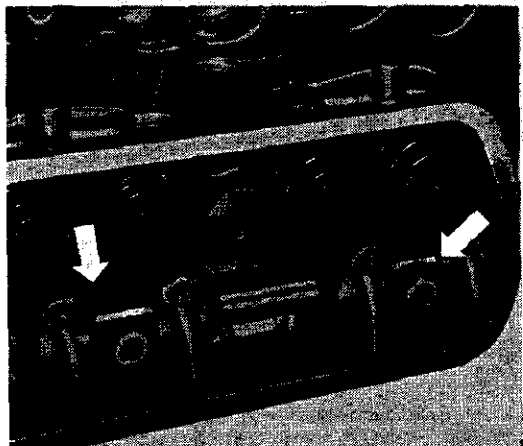
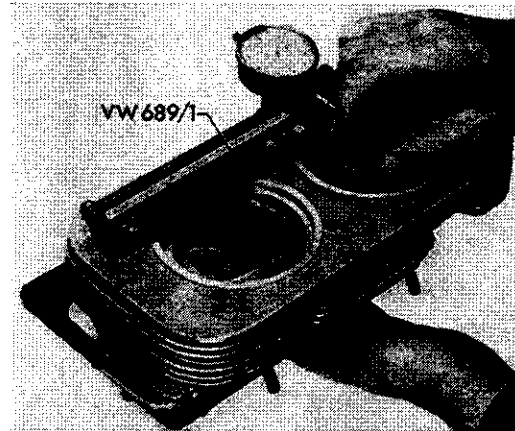


Fig. 8

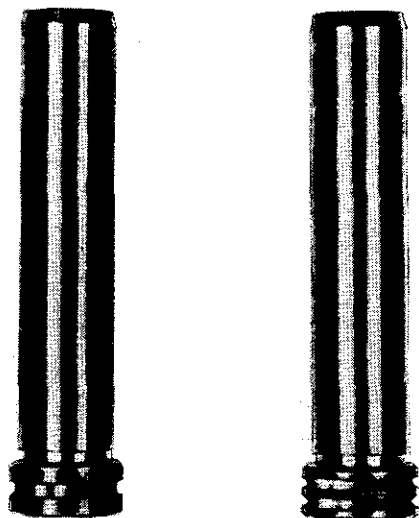
When repairing or replacing valves, it is necessary to check the valve guides for wear. Worn valve guides should be replaced.

Checking

- 1 - Remove deposits with a reamer.
- 2 - Place cylinder head on mounting plate VW 689/1 with the combustion chamber upward and fasten it with the guide.
- 3 - Insert dial gauge into bracket and attach dial gauge extension.
- 4 - Insert new valve into guide to be measured and hold it so that valve stem end is flush with end of valve guide.
- 5 - Set dial gauge and determine amount of rock.



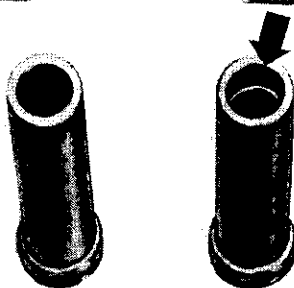
	Intake valve guide	Exhaust valve guide	Wear limit
Rock	0.21—0.23 mm (0.0082— 0.0090 in.)	0.23—0.27 mm (0.0090— 0.0106 in.)	0.8 mm (0.031 in.)
Inside dia- meter	8.00—8.02 mm diameter (0.3149—0.3156 in.)		8.06 mm (0.3172 in.)



Worn or damaged valve guides can be replaced with the universal cylinder head repair device. Replacement oversize valve guides are available.

1st oversize: 1 groove

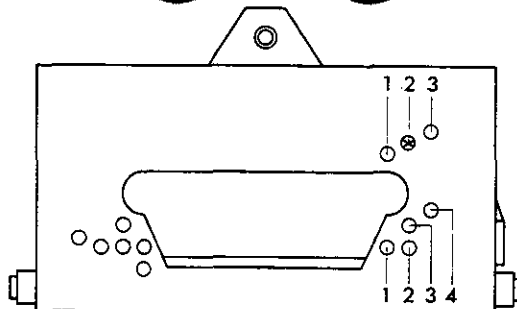
2nd oversize: 2 grooves



Means of identification:

Intake: Inside diameter **not** turned out

Exhaust: Inside diameter turned out (arrow)



Repair instructions

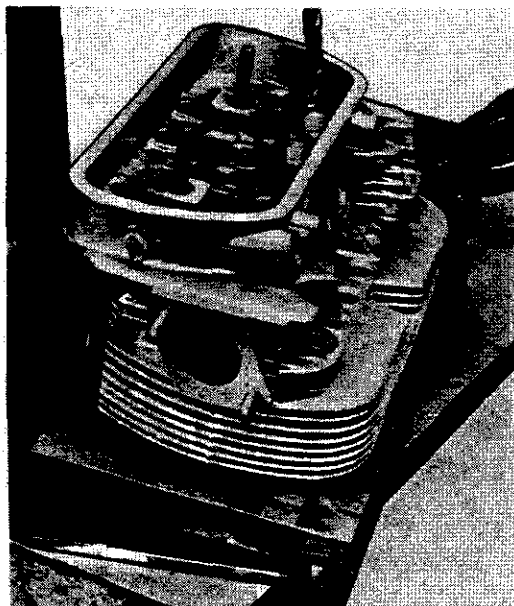
1 - Place head on device with combustion chambers facing the mouting plate.

2 - Adjust angle of plate to $9^{\circ} 30'$.

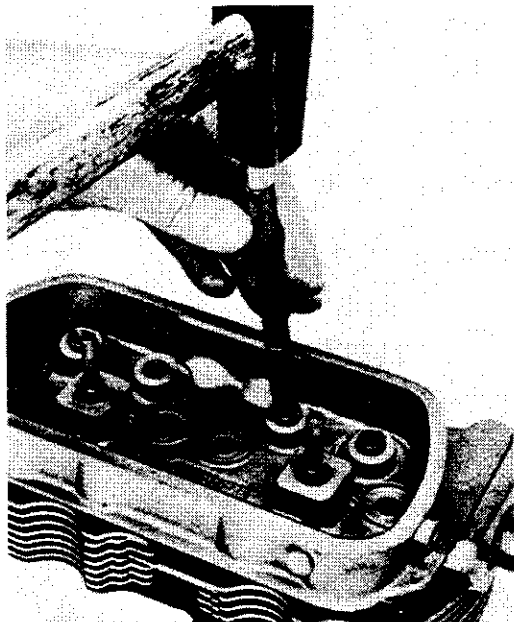
3 - Align plate on drill press table.

4 - Drill guides with shouldered drill to a depth of 40–50 mm ($1\frac{1}{2}$ –2 in.).

(Drill speed: approximately 100 rpm)



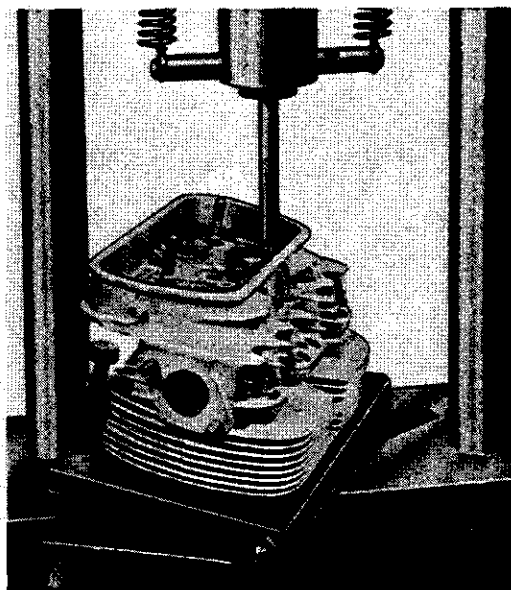
5 - Knock guides out with drift.



6 - Coat 1st oversize guide with engine oil and press it in.

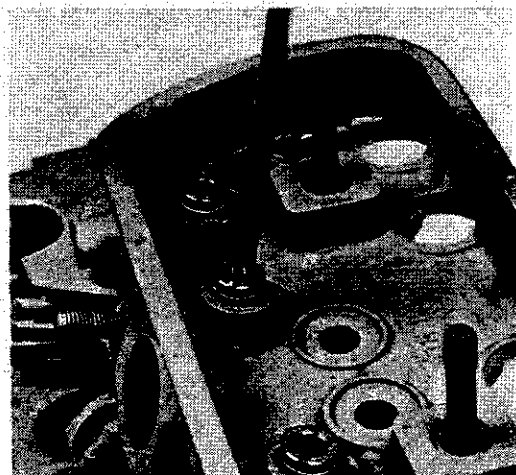
Note

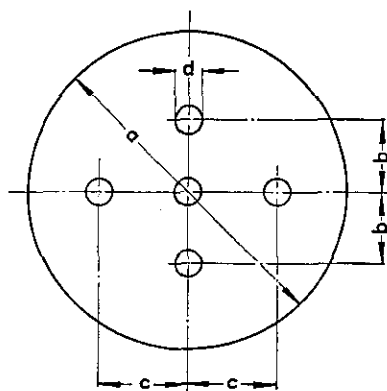
The pressure required should be between 1 and 2 tons. If the pressure is under 1 ton a 2nd oversize guide should be installed.



7 - Ream guides out. Use coolant when reaming.

8 - Check reamed guides for size.





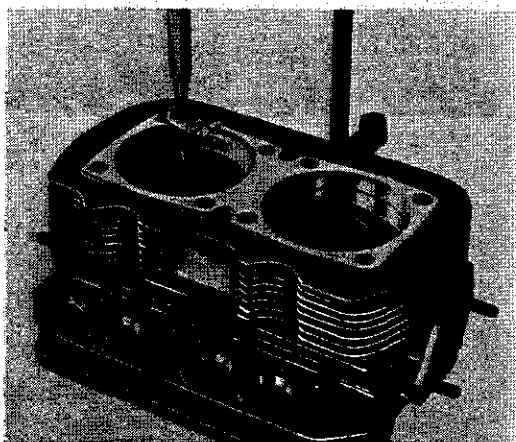
Testing devices needed:

- a - A small measuring burette of 100 cc capacity.
 - b - A transparent plastic plate of 10 mm (0.4 in.) thickness manufactured according to sketch.
- a = 93 mm (3.66 in.) diameter
 b = 40 mm (1.6 in.)
 c = 50 mm (2 in.)
 d = 7 mm (0.3 in.)

Testing

When measuring, valves must seal properly and spark plugs must be installed.

- 1 - Remove carbon deposits from combustion chamber. Especially clean surface on which the plastic plate is to be placed.
- 2 - Place the cylinder head in a horizontal position with the combustion chamber facing upward.
- 3 - Lightly coat contact surface of plastic plate with multipurpose grease.
- 4 - Place plastic plate in cylinder head and press firmly in position.
- 5 - Fill burette to zero mark with fuel, naphtha or soapy water.
- 6 - Fill combustion chamber up to the upper edges of the five holes in the plastic plate with the measuring fluid, ensuring that no air bubbles form. (If necessary, tilt cylinder head slightly.)



$$\text{Combustion chamber capacity} = \text{quantity of fluid put in} - \text{minus } 2 \text{ cm}^3 \text{ (0.122 cu. in.)}^*)$$

*) The capacity of the five holes (7 mm [0.3 in.] diameter $\times$ 10 mm [0.4 in.] deep) amounts to 2 cm³ (0.122 cu. in.).

Combustion chamber capacity of one cylinder in the cylinders heads:

Type/Model	Combustion chamber capacity in cm ³
up to July 1970	48.0–50.0 cm ³ (2.93–3.05 cu. in.)
from August 1970	50.0–52.0 cm ³ (3.05–3.17 cu. in.)

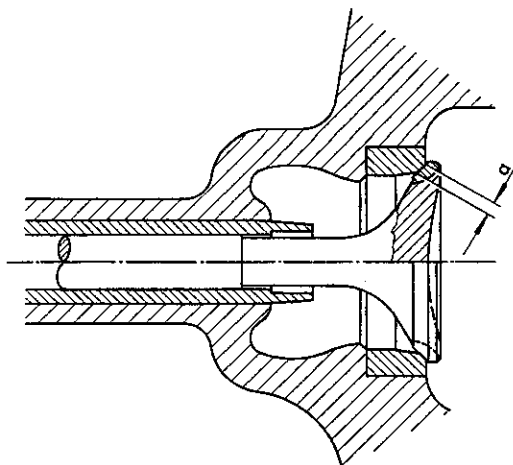
Damaged or burnt seats may be reconditioned as long as the permissible width for the seat is maintained. The outer edge of the 15° chamfer should not exceed the outer diameter of the valve seat insert. If the dimensions are no longer true, the cylinder head has to be replaced. Replacement of valve seats is beyond the scope of a normal workshop, as they are shrunk (chilled) into position.

Seat width (a):

new: Intake = 1.4–2.5 mm (0.055–0.10 in.)
Exhaust = 1.4–2.5 mm (0.055–0.10 in.)

when repairing:

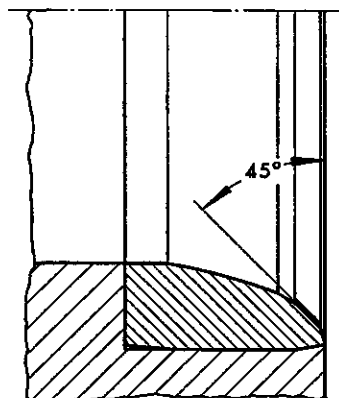
Intake = 1.3–1.6 mm (0.051–0.063 in.)
Exhaust = 1.7–2.0 mm (0.067–0.079 in.)



Sequence of operations

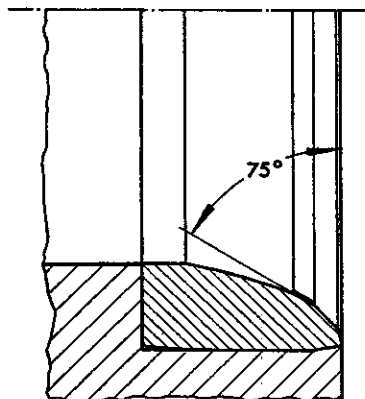
1 - Cut 45° faces.

Cut valve seat inserts carefully to obtain a perfectly concentric seating surface. Remove only the minimum of metal, otherwise the life of the inserts will be adversely affected. Stop grinding as soon as the whole surface is cut.



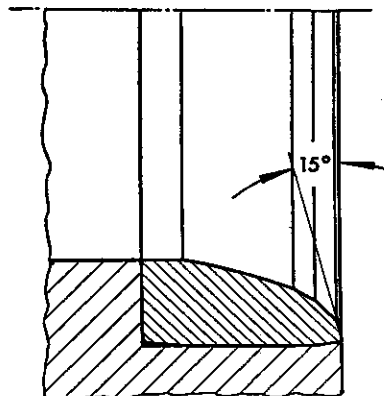
2 - Cut 75° face.

Slightly chamfer lower edge of exhaust valve seat insert.



3 - Cut 15° face.

Chamfer upper edge of valve seat insert until correct seat width is reached.



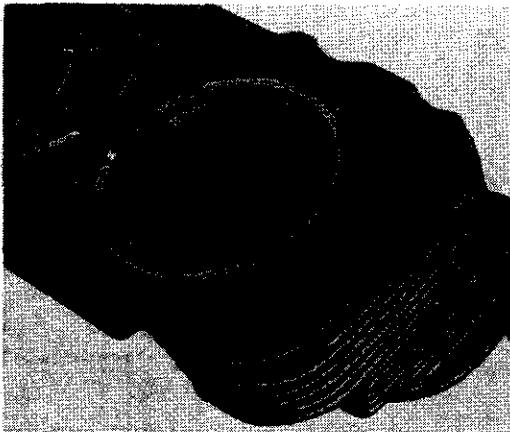
4 - The valve seats can be checked with a new valve.

Checking valve seating

With accurately refaced valve seats and new valves it is usually not necessary to lap the valves.

Preparing contact pattern

- 1 - Lightly coat the valve with Prussian blue.
- 2 - Insert valve into valve guide. Apply light pressure and turn the valve approximately $\frac{1}{4}$ turn on the valve seat.
- 3 - Carefully remove valve. The contact pattern will show which parts are not seating properly. If necessary lap valves.

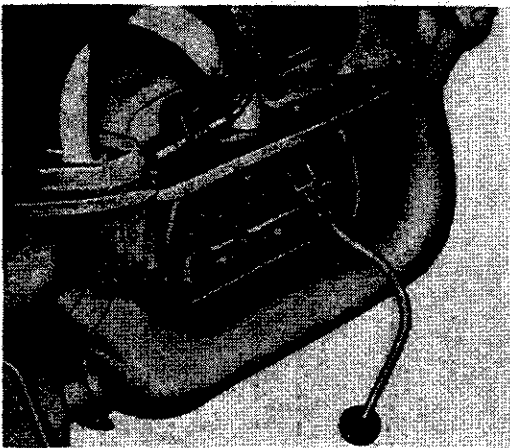


Lapping valves

- 1 - Coat valve seat with a fine valve grinding compound and insert valve into guide.
- 2 - Place plunger on valve head and lap valve seat by turning the plunger handle. Lift valve frequently. Turn it evenly to avoid grooves in seating surfaces

Note

After lapping, thoroughly clean off all traces of lapping compound.



Removing and installing a valve spring (engine installed)

Removing

- 1 - Remove rocker shaft with rocker arms and sealing rings.
- 2 - Install tool VW 653/2 in place of rocker shaft.
- 3 - Install compressed air hose adapter into spark plug hole and apply pressure.
- 4 - Press spring cap down.
- 5 - Remove cotter, spring cap and valve spring.

Installing

- 1 - Check valve spring.
- 2 - Check cotter.

Valve clearance

The valve clearance must only be checked or adjusted with the engine cold.

Valve clearance:

Intake 0.15 mm (0.006 in.)

Exhaust 0.15 mm (0.006 in.)

The clearance **increases** at first as the engine warms up and then goes back to the proper setting when engine is really warm. It should be carefully checked at the prescribed intervals.

Valve adjustment gives the desired result only if the valves seal tightly, there is no undue clearance in the valve guides, and the stem end is not worn.

Insufficient valve clearance causes:

- Burning of valves and valve seats.
- Distortion of valves.
- Poor performance due to reduced compression.
- Uneven engine running.
- Altered valve timing.

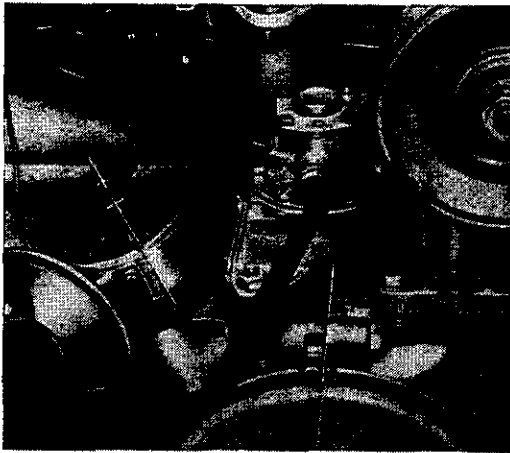
Excessive valve clearance causes:

- Noisy timing mechanism.
- Uneven engine running.
- Altered valve timing.
- Poor performance resulting from insufficient cylinder charge.

Adjusting valves

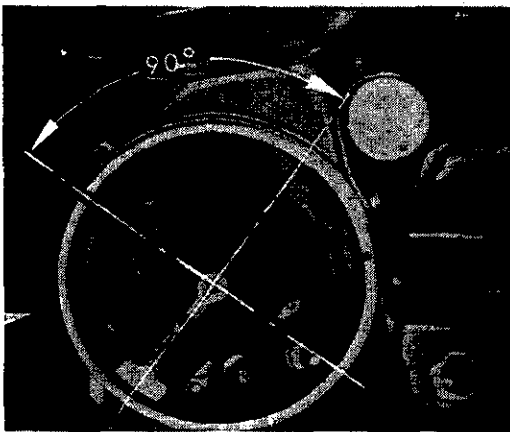
The valve clearance is adjusted in cylinder sequence 1-2-3-4.

The piston of the cylinder to be adjusted must be at TDC of the compression stroke, as the two valves are then closed.



- 1 - Set No. 1 cylinder to firing position.
- 2 - Check valve clearance with a feeler gauge.
- 3 - Adjust clearance with special wrench and a feeler gauge.

The clearance is correct if the feeler blade slides between screw and stem quickly and smoothly.



- 4 - When adjusting the valves of No. 2, 3 and 4 cylinders, the crankshaft must be turned to the left until rotor arm has moved 90° each time.

No.	Description	Qty.	removing	Note when installing	Special instructions see
1	Cylinder	4	Before removing cylinders, mark them so that they can be installed in the same location. If necessary, replace by another matched cylinder and piston of the same size.	Check cylinders for wear. Cylinder seating surface on crankcase and in cylinder head, cylinder seating shoulders and gaskets must be perfectly clean on installation. Foreign matter at this point could cause cylinder distortion and leaks. Oil the cylinder wall. Compress the rings with the compressing tool. The crankcase studs must not contact the cylinder cooling fins.	M 6.2/4.1 Fig. 3
2	Sealing ring between cylinder and crankcase	4		replace	
3	Upper piston ring	4	} use piston ring pliers	Fit rings by checking gap with a feeler gauge. The mark "Top" on the rings must point toward the piston crown. Make sure that the ring gaps are equally offset.	Fig. 2 M 6.1/3-1 M 6.2/3-2
4	Lower piston ring	4			
5	Oil scraper ring	4			
6	Spring clip	8	remove with VW 122 b		Fig. 4
7	Piston	4	mark before removing	Check for wear, note matching with cylinder; warm to fit piston pin; oil; note weight, max. 10 g.	M 6.2/4-1 Fig. 1
8	Piston pin	4	use VW 207	oil piston, if necessary warm up piston	M 6.2/3-2
9	Deflector plate	2			

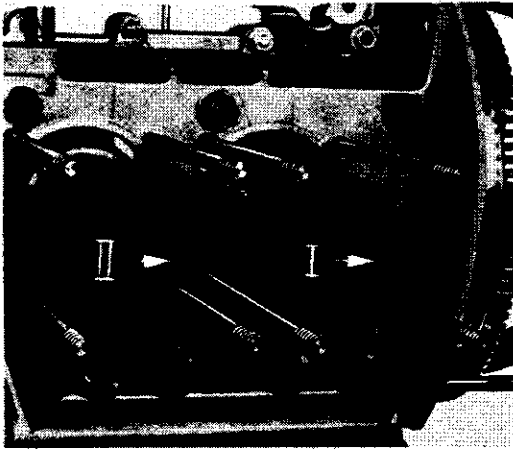


Fig. 1

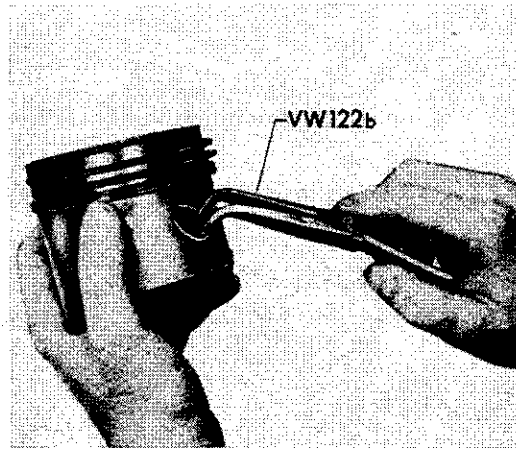


Fig. 4

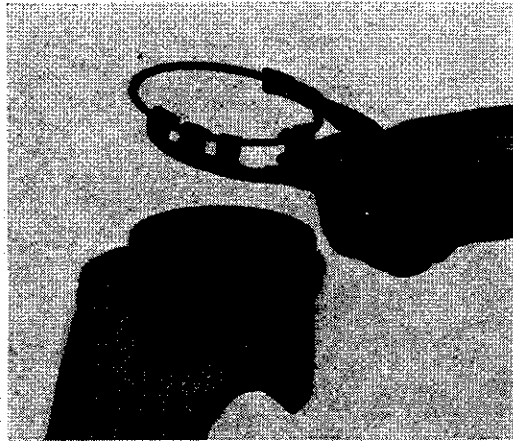


Fig. 2

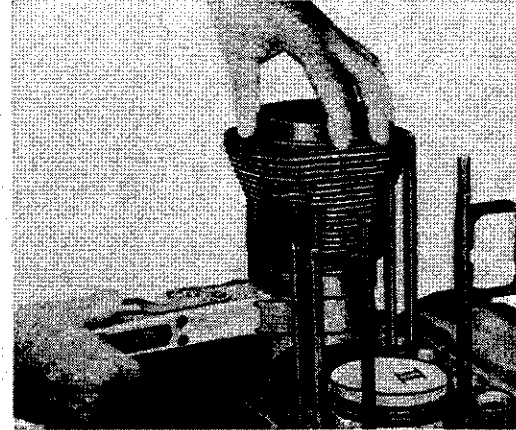


Fig. 5

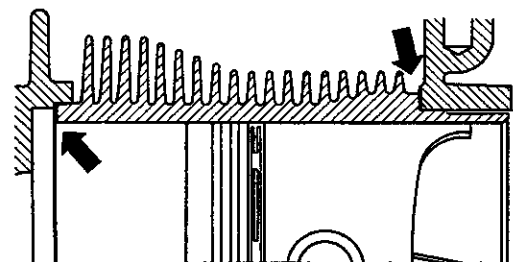
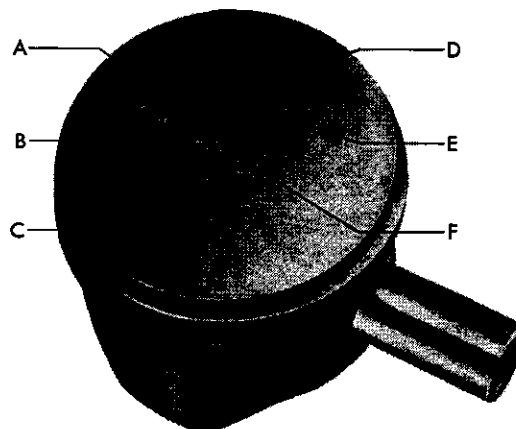


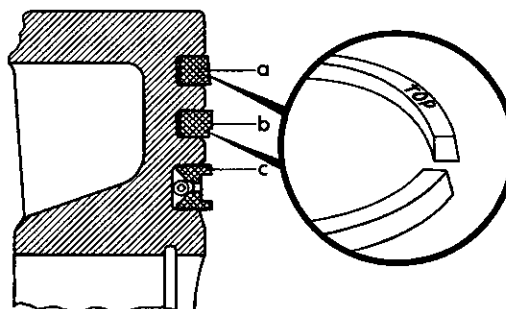
Fig. 3

Marking of pistons

- A - The letter near the arrow corresponds to the index of the part number of the piston concerned. It serves as an identification mark.
- B - Arrow must point towards the flywheel when piston is installed.
- C - Paint spot indicating matching size (blue, pink, green).
- D - Details of weight grading (+ or -).
- E - Paint spot indicating weight grading (brown = - weight, gray = + weight).
- F - Piston size in mm.

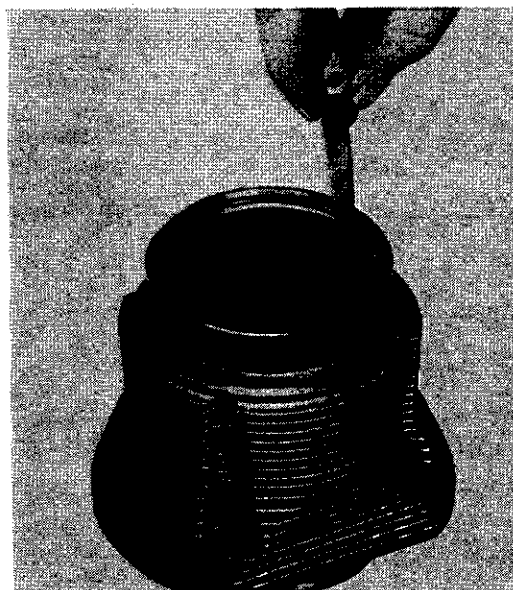
**Types of piston rings**

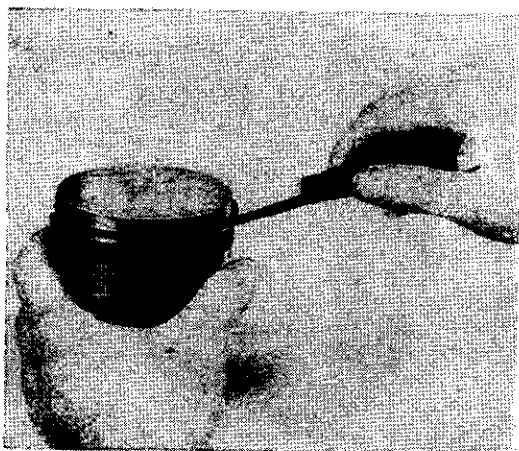
Upper ring	Ferrox insert, thickness: 2 mm (0.08 in.)
Lower ring	narrow face, thickness: 2 mm (0.08 in.)
Oil scraper ring	with coil spring



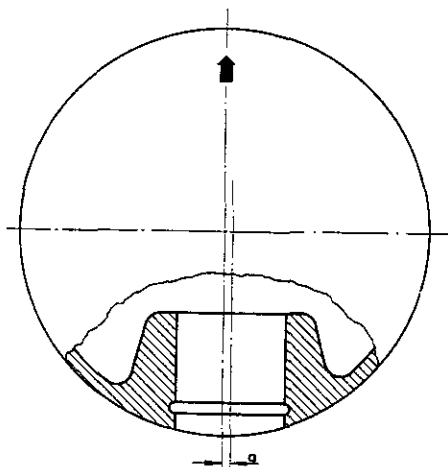
- a - Upper ring
- b - Lower ring
- c - Oil scraper ring

	Gap mm (in.)	Wear limit mm (in.)
Upper ring	0.30–0.45 (0.012–0.018)	0.90 (0.035)
Lower ring	0.30–0.45 (0.012–0.018)	
Oil scraper ring	0.25–0.40 (0.010–0.016)	0.95 (0.037)





	Clearance mm (in.)	Wear limit mm (in.)
Upper ring	0.07–0.10 (0.0027–0.004)	0.12 (0.005)
Lower ring	0.05–0.07 (0.002–0.0027)	0.10 (0.004)
Oil scraper ring	0.03–0.05 (0.001–0.002)	



Offset of piston pin bore

"a" = 1.5 mm (0.06 in.)

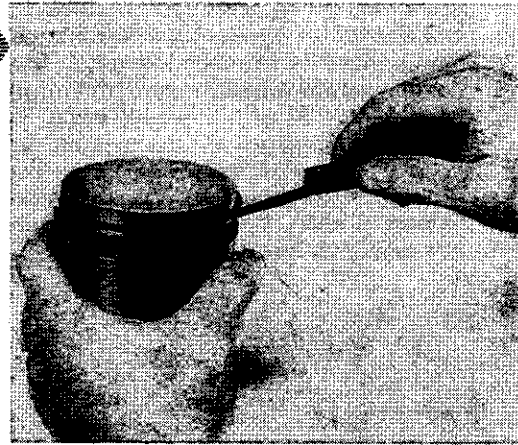
Piston pin and connecting rod bushing

Check and fit piston pin. Depending on the combination of tolerances between piston pin and bearing, the pin may be found to be a light finger-push fit in the piston without heating the piston. This condition is quite normal, even if the piston pin should slide out of the piston under its own weight. There is no reason whatsoever to replace piston pin, piston, or both, in this connection.

	Diameter mm (in.)	Clearance mm (in.)	Wear limit mm (in.)
Piston pin bushing	22.008–22.017 (0.8664–0.8667)	0.008–0.021 (0.0003–0.0008)	0.04 (0.0016)
Piston pin	21.996–22.000 (0.8658–0.8661)		
Bore in piston	21.997–22.002 (0.8660–0.8668)		

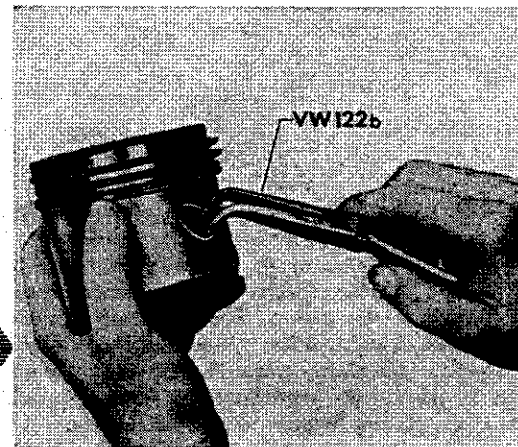
If the clearance between pin and bushing is near the wear limit of 0.04 mm (0.0015 in.), fit a new pin and a new bushing in the connecting rod.

- 5 - Check the ring clearance in the grooves with a feeler gauge.



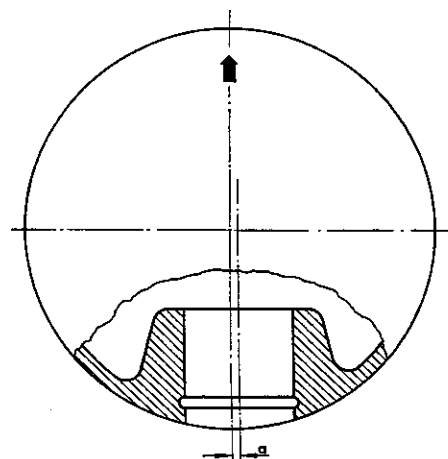
	Clearance mm (in.)	Wear limit mm (in.)
Upper ring 1/1500, 1600 — 2/1600 — 3/1600	0.07—0.10 (.0027—.004)	0.12 (.005)
Lower ring 1/1500, 1600 — 2/1600 — 3/1600	0.05—0.07 (.002—.0027)	0.10 (.004)
Oil scraper ring 1/1500, 1600 — 2/1600 — 3/1600	0.03—0.05 (.0012—.002)	

- 6 - Install circlips on the flywheel side of pistons for cylinders 1 and 2 and on the opposite side of pistons for cylinders 3 and 4.



Offset of piston pin bore

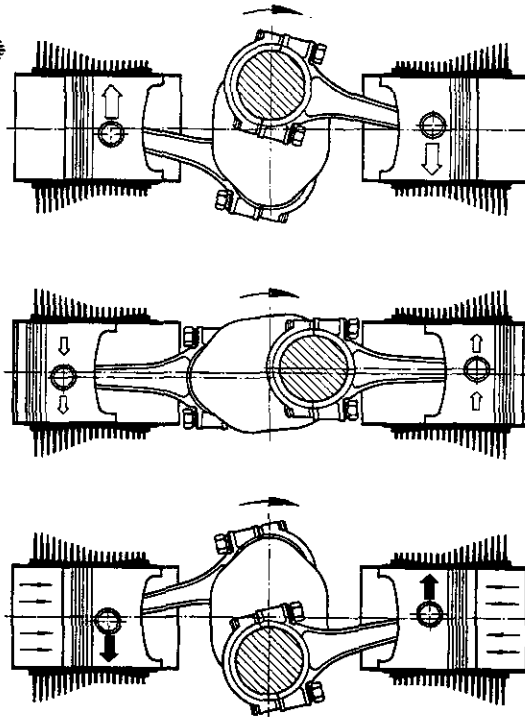
The piston pin eye in the piston is offset. When installing the pistons ensure that the arrow or the word "vorn" is toward the flywheel.



Type/Model	"a"
1/1500, 1600 — 2/1600 — 3/1600	1.5 mm

M6.2 Cylinders and Pistons

Due to the piston pin offset, the connecting rod changes its angle and with it the pressure contact area before reaching TDC. Combustion has not yet taken place at this point and the side thrust is relatively small. The piston tilts gently toward the opposite side of the cylinder wall, thus avoiding the usual slapping noise caused by the piston, tilting especially when clearance between piston and cylinder is large.



- 7 - Check and fit piston pin. Depending on the combination of tolerances between piston pin and bearing, the pin may be found to be a light finger-push fit in the piston without heating the piston. This condition is quite normal, even if the piston pin should slide out of the piston under its own weight. There is no reason whatsoever to replace piston pin, piston, or both, in this connection.

If the clearance between pin and bush is near the wear limit of .0015 in. (0.04 mm), fit a new pin and a new bush in the connecting rod.

Pistons should be heated in all cases where the piston pin is not a push fit. The piston is heated to approximately 176° F (80° C). The pin is then pushed fully home as far as the circlip in one movement with the drift VW 207 or VW 207 c.

- 8 - Insert second circlip. The circlips must seat correctly in their grooves.

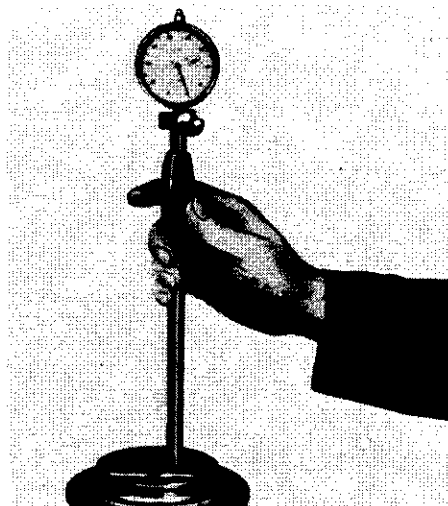
	1/1500, 1600 — 2/1600 — 3/1600 mm dia.	Clearance mm	Wear limit mm
Piston pin bush	20.008—22.017	0.008	0.04
Piston pin	21.996—22.000	0.021	
Bore in piston	21.997—22.002		

The clearance should be determined by measuring cylinder and piston and not with a feeler gauge.

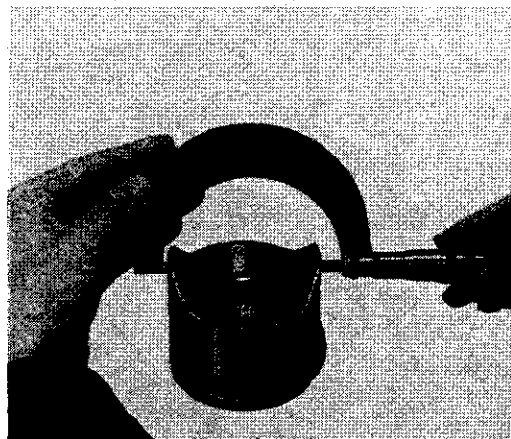
The cylinder is measured with a special dial gauge which is adjusted with micrometer gauge to the size of the cylinder.

The cylinder should be measured 10–15 mm (0.4–0.6 in.) below the upper edge.

New part	Wear limit
0.04–0.05 mm (0.00157–0.00196 in.)	0.2 mm (0.008 in.)



The nominal diameter is stamped on the piston crown. The reading must be taken at the bottom of the skirt at right angles to the piston pin axis.



The size gradings of the cylinders and matching pistons are as follows:

Gradings	Color	Cylinder diameter mm	Matching piston diameter mm
Standard size			
Nominal dimension 85.5 mm diameter	Blue	85.492–85.508	85.45
	Pink	85.502–85.518	85.46
1st Oversize			
Nominal dimension 86 mm diameter	Blue	85.992–86.008	85.95
	Pink	86.002–86.018	85.96
2nd Oversize			
Nominal dimension 85.5 mm diameter	Blue	86.492–86.508	86.45
	Pink	86.502–86.518	86.46

If measurement of piston and cylinder shows that the clearance is near 0.2 mm (0.008 in.), the piston and cylinder should be replaced by a set of the same size grading (normal or oversize).

The difference in weight between the pistons in **one** engine must not exceed 10 grams. Pistons must not be replaced individually if the cylinders to which they belong show signs of wear.

If the cylinder of a damaged piston shows no signs of wear it is usually sufficient to install a new piston of the appropriate matching size.

Since the compression ratio must not be affected when installing reconditioned cylinders, the distance from the crown to the piston pin eye of the oversize piston is reduced accordingly.

Note

The cylinders and pistons in one engine must be of the same size grading.

Besides wear, the oil consumption of the engine is an important factor in deciding whether or not a new cylinder and piston must be installed.

Oil consumption is considered excessive if it is more than 2 pints per 600 miles.

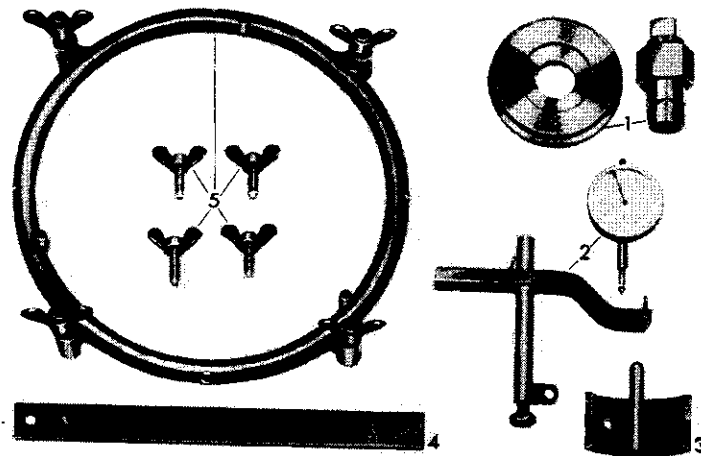
If measurement of piston and cylinder shows that the clearance is near 0.2 mm (.008 in.), the piston and cylinder should be replaced by a set of the same size grading (normal or oversize). The difference in weight between the pistons in **one** engine must not exceed 10 grams. Pistons must not be replaced individually if the cylinders to which they belong show signs of wear. If the cylinder of a damaged piston shows no signs of wear it is usually sufficient to install a new piston of the appropriate matching size.

Since the compression ratio must not be affected when installing reconditioned cylinders, the distance from the crown to the piston pin eye of the oversize piston is reduced accordingly.

Important

The cylinders and pistons in one engine must be of the same size grading.

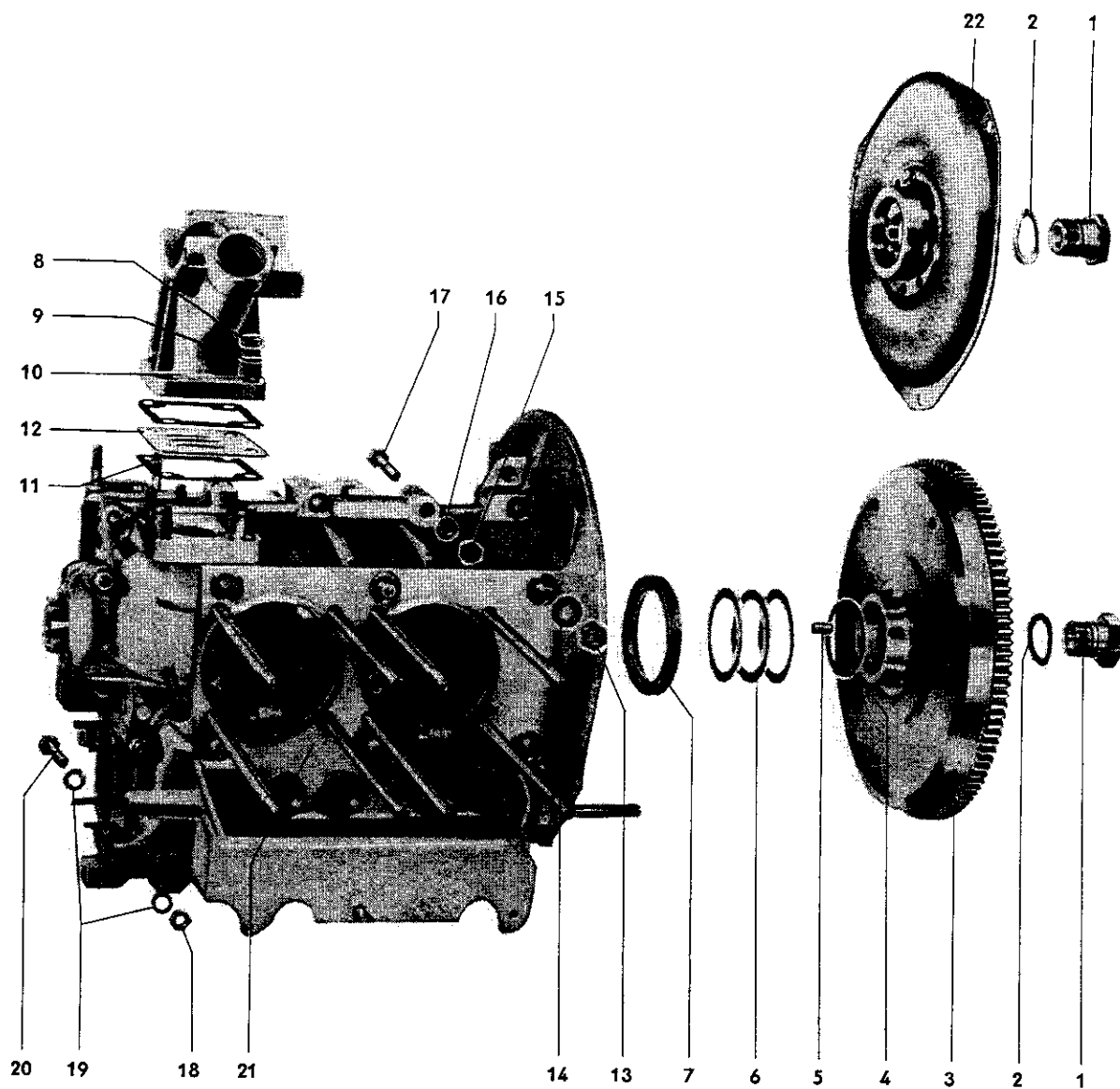
Beside the wear, the oil consumption of the engine is an important factor in deciding whether or not a new cylinder and piston must be installed. Oil consumption is considered excessive if it is more than 2 pints per 600 miles (1 liter per 1000 km), on Type 2/1600, 3 pints per 600 miles (1.4 liter per 1000 km).



No.	Description	Special tool	Remarks
1	Installing tool for crankshaft oil seal	VW 204 b	
2	Dial indicator bracket	VW 659/2	
3	Retainer for flywheel	VW 215 c	
4	Stop bar, carrier plate	VW 802	
5	Drive plate retainer	VW 184	

M

Type 1 Crankcase, Flywheel, Camshaft, Crankshaft and Connecting Rods

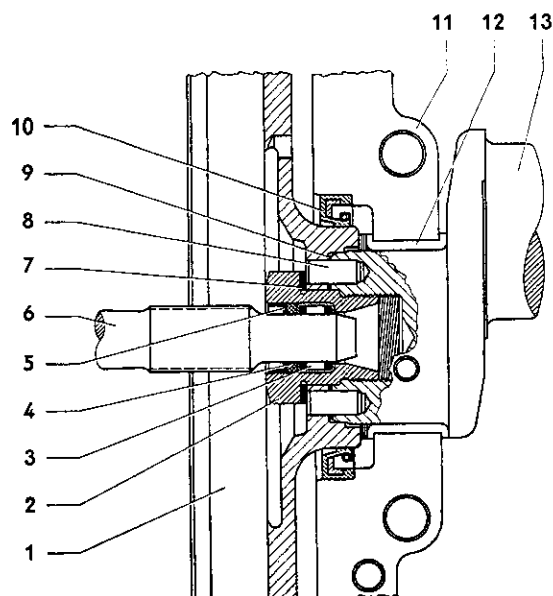


cardiagn.com

No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Gland nut *)	1		torque to 35 mkg (253 ft. lb.)	M 7.1/2
2	Lock washer	1			
3	Flywheel	1	mark installation position and note when installing	friction surface must be free of oil and grease	M 7.1/2
4	Rubber seal	1		replace, oil lightly	
5	Flywheel dowel pin	4		check; replace if necessary	
6	Shim	3		use dial gauge bracket VW 659/2 determine thickness by setting axial play 0.07–0.13 mm (0.003–0.005 in.)	M 7.1/2
7	Crankshaft oil seal	1		replace; install with VW 204 b	M 7.1/3-1
8	Nut M 8, galvanized	4			
9	Lock washer, galvanized	4			
10	Generator support	1			
11	Generator support gasket	2		replace, if present	
12	Oil deflector plate	1		replace, if raised edge type; note installation position	M 7.1/2
13	Nut M 12×1.5	6		torque to 3.5 mkg (25 lb. ft.)	
14	Washer, 12.2×22	6			
15	Nut M 8, galvanized	6		torque to 2 mkg (14 lb. ft.) note sequence	
16	Lock washer, galvanized	6			
17	Bolt M 8×50, galvanized	1			
18	Nut M 8	9		torque to 2 mkg (14 lb. ft.) note sequence	
19	Lock washer	11			
20	Bolt M 8×50	2			
21	Crankcase	1		check for wear, clean joints, break edges of bearing bores	M 7.1/2
22	Plate	1			M 7.1/2

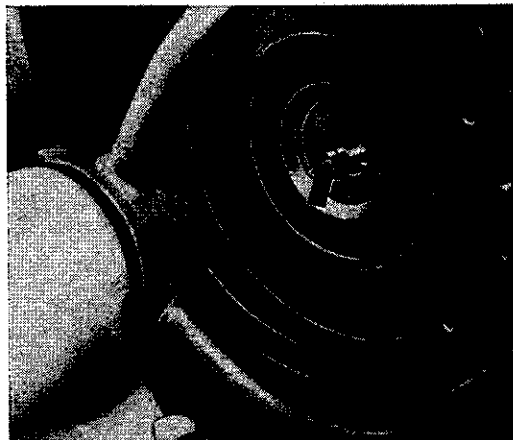
*) Type 1/Automatic Stick Shift gland nut without needle bearing and felt ring, 6 mm thinner hex.

- | | |
|----------------------|--------------------------|
| 1 - Flywheel | 8 - Dowel pin |
| 2 - Gland nut | 9 - Rubber sealing ring |
| 3 - Needle bearing | 10 - Crankshaft oil seal |
| 4 - Felt ring | 11 - Shims |
| 5 - Retaining ring | 12 - Crankshaft bearing |
| 6 - Main drive shaft | 13 - Crankshaft |
| 7 - Lock washer | |

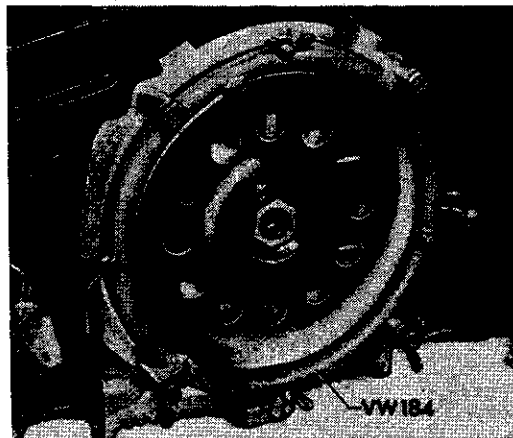


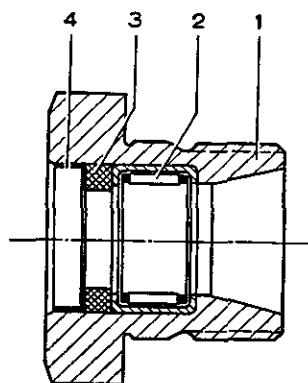
Removing

- 1 - When new engines have been assembled they are balanced. For this reason, mark position of flywheel (arrow) so that it is not too much out of balance when installed again.



- 2 - On engines of Automatic Stick Shift vehicles, the drive plate is held with VW184 when unscrewing the gland nut.





- | | |
|--------------------|---------------|
| 1 - Gland nut | 3 - Felt ring |
| 2 - Needle bearing | 4 - End ring |

Checking flywheel

- 1 - Check flywheel teeth for wear and damage. A maximum of 2 mm (0.078 in.) can be removed from a damaged gear ring on the clutch side. After deburring, chamfer the teeth.
- 2 - Check dowel pin holes in the crankshaft for wear.
- 3 - Check needle bearing for wear.

Installing

- 1 - Lubricate needle bearing with a small amount of multipurpose grease only if it has been washed. Oil felt ring. Wipe excess lubricant off.
- 2 - Note mark denoting unbalance.
- 3 - Adjust axial play of crankshaft.

Disassembling crankcase

Use a rubber hammer to loosen the right-hand crankcase half. Do not insert sharp tools, such as screwdrivers etc., between the joining faces.

Checking

Note

Both halves of crankcase are machined together and must be replaced together.

- 1 - Flush the oil passages and blow them out with compressed air.
- 2 - Check studs for tightness. If the tapped holes are worn, Heli-Coil inserts can be installed.

Note

When replacing the crankcase of an engine manufactured before August 1970, various other parts will have to be replaced as well (see Parts Bulletin 1-12).

If the old cylinder head studs are to be used again in the new crankcase, the front stud above cylinder No. 3 must be replaced by a longer stud (see Parts Bulletin 1-12).

Assembling

- 1 - Spread an even film of sealing compound on the jointing faces of the crankcase halves. Be extremely careful not to let any sealing compound enter oil passages of crankshaft and camshaft bearings.

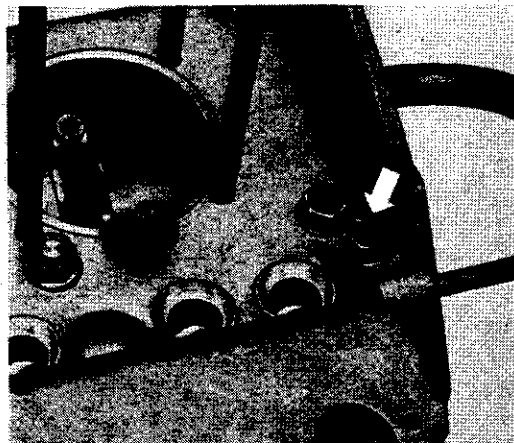
- 2 - Assemble housing halves.

- 3 - First tighten M 8 nut next to M 12 stud of main bearing No. 1 (arrow).

Then tighten M 12 nuts. This tightening sequence must be adhered to.

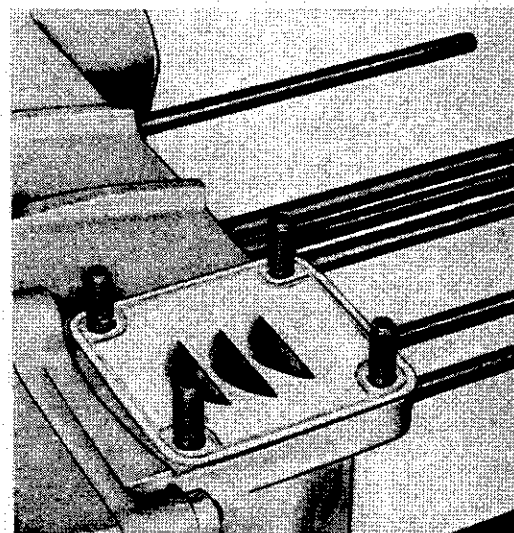
- 4 - Tighten M 8 and M 6 nuts.

- 5 - Turn the crankshaft to check for ease of movement.



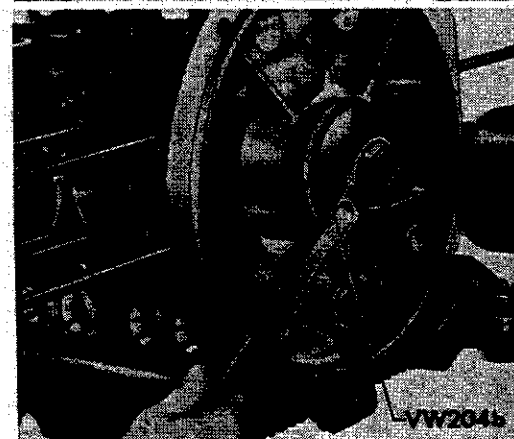
- 6 - Install oil deflector plate between crankcase and generator support or breather support.

The three louvers in the oil deflector plate face downward and the slightly longer end of the louver faces rearward. The upper face of the plate is marked "top".

**Installing crankshaft oil seal**

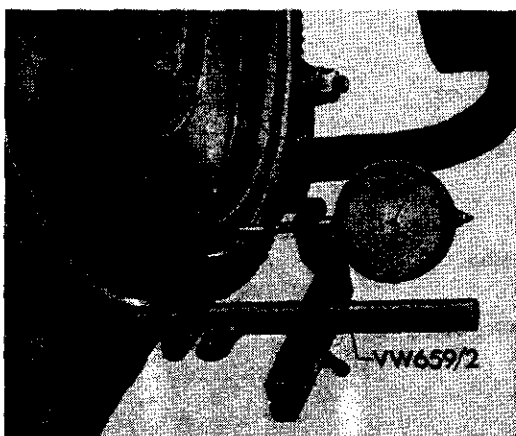
Clean oil seal recess in crankcase and coat it with a thin film of sealing compound. If necessary, slightly chamfer the outer edge with a scraper to prevent the outer surface of the oil seal from being damaged. Remove metal shavings.

The oil seal must bed squarely in the crankcase recess.



M

Type 1 Crankcase, Flywheel, Camshaft, Crankshaft and Connecting Rods



Checking

Crankshaft end play:

New — 0.07 to 0.13 mm (0.0027 to 0.005 in.)

Wear limit — 0.15 mm (0.006 in.)

Move crankshaft in and out and read axial play directly from dial gauge.

Adjusting end play

1 - Install flywheel with two shims but without the seals for crankshaft and flywheel.

2 - Attach dial gauge bracket VW 659/2 and dial gauge to crankcase.

3 - Move crankshaft in and out. Read end play off dial gauge.

4 - Determine thickness of third shim:

Dial gauge reading

— 0.10 (mean end play)

= third shim

5 - Remove flywheel.

6 - Insert seals for crankshaft and flywheel.

7 - Install flywheel and all three shims.

8 - Check end play again.

The thickness is etched on each shim. If necessary, measure the thickness with a micrometer.

Three shims of the required total thickness are to be installed.

Available shims:	Inside diameter in mm	Thickness in mm
	53.6	0.24
		0.30
		0.32
		0.34
		0.36

No.	Description	Qty.	disassembling	Note when assembling	Special instructions see
1	Camshaft	1	Check rivets and wear on bearings, journals and cams. Check gearwheel for wear and contact pattern.	Check run-out, max. when new 0.02 mm (0.0007 in.), wear limit: 0.04 mm (0.0015 in.) (measured at center bearing). Check axial play at thrust bearing: 0.04 to 0.13 mm (0.0015 to 0.0051 in.), wear limit: 0.16 mm (0.0062 in.). Watch matching and fitting position. Check backlash on full circumference of gearwheel.	M 7.2/2 Fig. 1 Fig. 2 Fig. 3 M 5.1/3
2	Crankshaft and connecting rods	1		edges of oil holes in crankshaft journals and bearings must be chamfered	M 7.2/2-2
3	Main bearing no. 1	1		check for wear apply oil; hole for dowel pin faces flywheel. Bearing play with housing pre-load: new — 0.04 to 0.10 mm (0.0015 to 0.0039 in.) wear limit: 0.18 mm (0.007 in.)	
4	End cap for camshaft bore	1		install with sealing compound; on engines with Automatic Stick Shift transmissions, base faces camshaft	
5	Camshaft no. 1 bearing shell	1	}	check for wear apply oil; tabs engage in recesses in crankcase	
6	Camshaft no. 2 bearing shell	1			
7	Left shell for no. 3 camshaft bearing (with thrust shoulder)	1			
8	Cam follower	4		check for wear, oil	
9	Shell for crankshaft no. 2 bearing	1		check for wear, oil bearing play with housing pre-load: new — 0.03 to 0.09 mm (0.001 to 0.003 in.) wear limit: 0.17 mm (0.006 in.)	
10	Dowel pin for crankshaft bearing	4		check for tightness	Fig. 4
11	Crankcase joint seal	6		replace	
12	Left crankcase half	1			
The following parts are not shown in the illustration but they are installed in right-hand half of crankcase before assembly:					
(13)	Dowel pin for crankshaft bearing no. 2	1		check for tightness	
(14)	Shell for crankshaft bearing no. 2	1		check for wear, oil	
(15)	Shell for camshaft bearing no. 1	1	}	check for wear, tabs engage in recess in crankcase; oil	
(16)	Shell for camshaft bearing no. 2	1			
(17)	Shell for camshaft bearing no. 3	1			
(18)	Cam follower	4		check for wear apply oil; hold with spring clips VW 171	

Note

The backlash between camshaft and crankshaft gears should be: 0.00–0.05 mm (0.00–0.002 in.).

The camshaft gear size is correct if the backlash is hardly noticeable and the camshaft does not lift when crankshaft is turned backward.

To assist in obtaining the specified backlash camshafts are available with various sized timing gears under different part numbers.

The camshaft gears are marked, for example –1, 0, +1, +2 on their inner face. The digits indicate in $\frac{1}{100}$ mm how much the pitch radius departs from the standard pitch radius which is denoted by "0".

Caution

The mark "0" (arrow) on the outer face of each camshaft timing gear is to ensure correct timing and must not be confused with the markings on the inner face.

The crankshaft timing gear is obtainable in one size only and has no special marking.

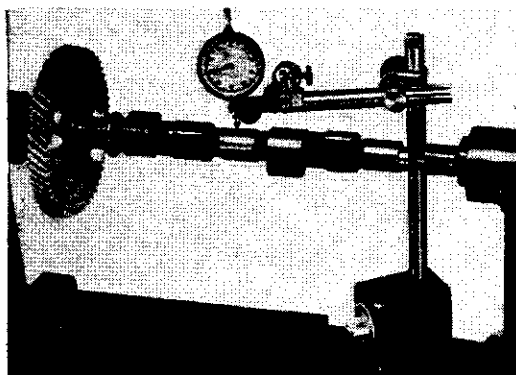


Fig. 1

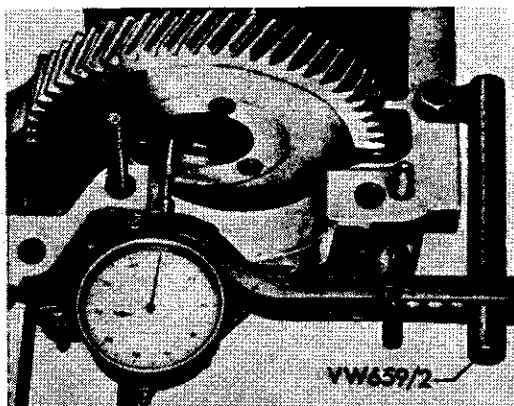


Fig. 2

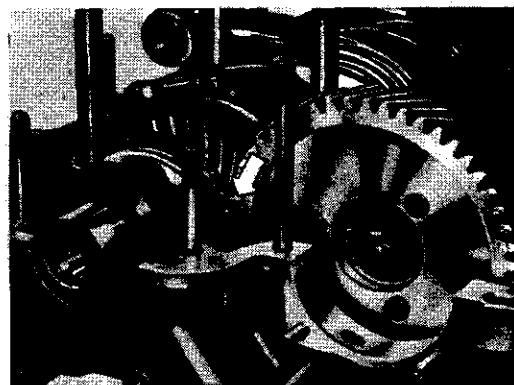


Fig. 3

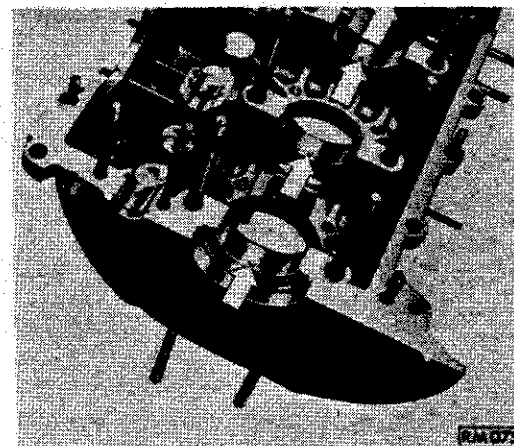


Fig. 4

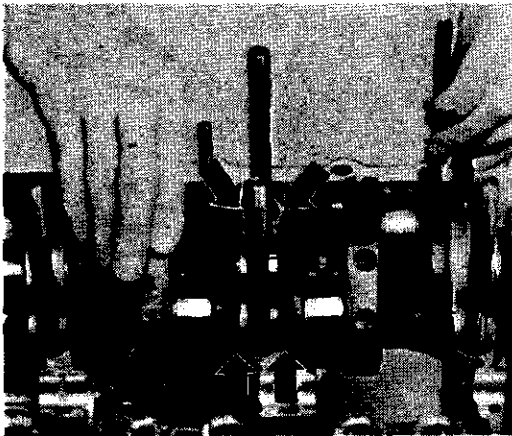
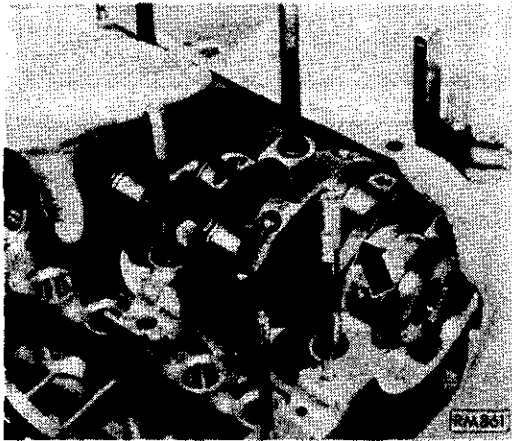
M

Type 1 Crankcase, Flywheel, Camshaft, Crankshaft and Connecting Rods

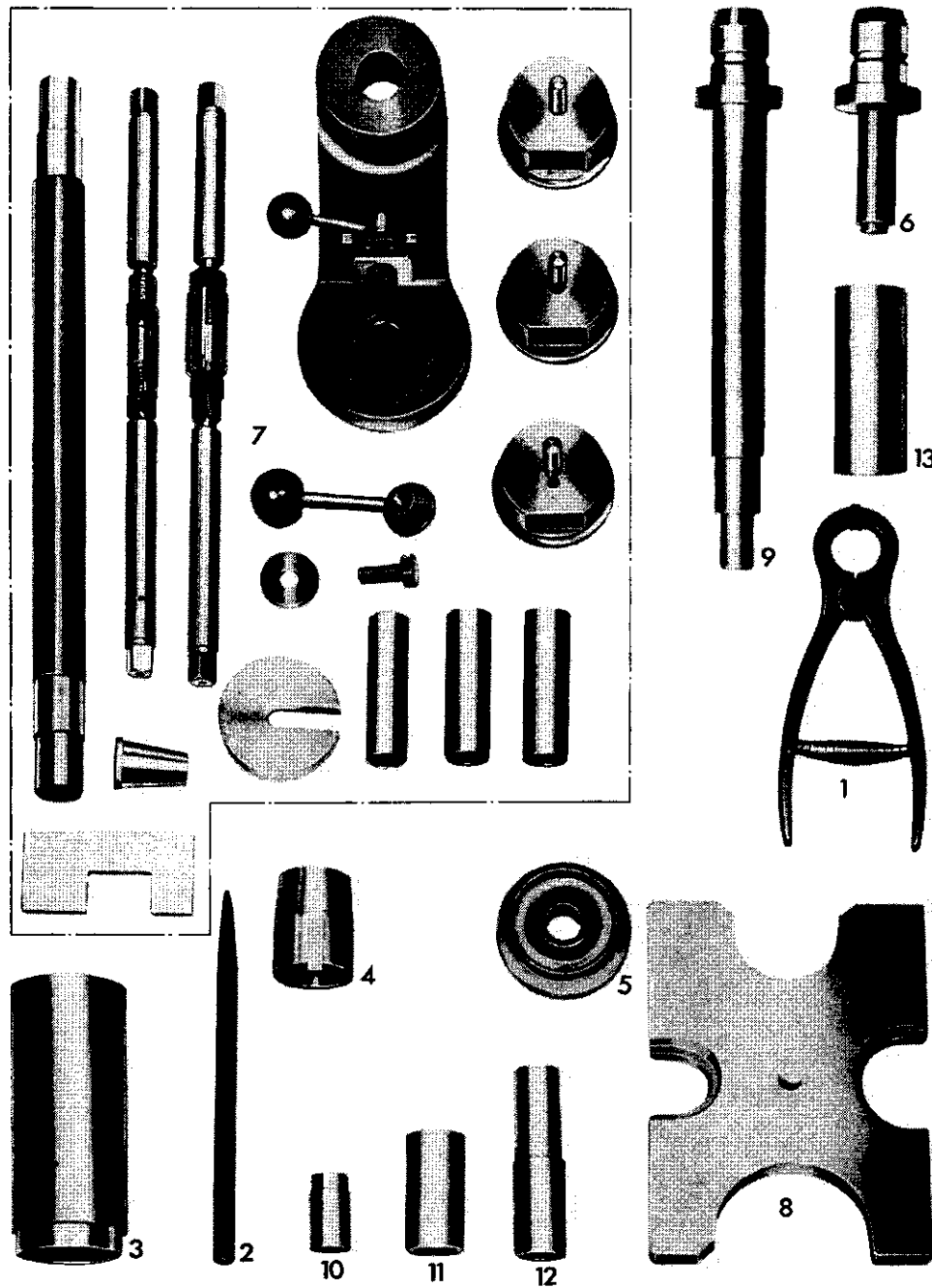
Note

If a new crankcase (with threaded inserts) is to be used as a replacement for an old crankcase (without threaded inserts) and the same crankshaft is to be reused, note the following:

- 1 - Place the crankshaft with bearings in the left half of the crankcase.
- 2 - Push a 0.5 mm (0.020 in.) feeler gauge blade between main bearing I and the crankshaft (arrow).



- 3 - Turn the crankshaft, under light pressure, against the feeler gauge blade and note the clearance at main bearing web II. If the crankshaft contacts the housing (arrow), both crankcase halves must be ground off at the locations concerned.



No.	Description	Special tool	Remarks
1	Circlip pliers	VW 161 a	
2	Peening chisel	VW 124 a	
3	Tube, 60 mm diameter	VW 415 a	
4	Guide sleeve, tapered	VW 428 a	
5	Thrust pad	VW 442	
6	Punch	VW 409	
7	Connecting rod repair tool	VW 214 f	
8	Thrust plate (converted)	VW 402	
9	Punch	VW 408 a	
10	Arbor	VW 434	
11	Tube, 31,5 mm diameter	VW 418 a	
12	Tube, 28 mm diameter; 100 mm	VW 421	
13	Tube, 37 mm diameter	VW 416 b	



Fig. 1

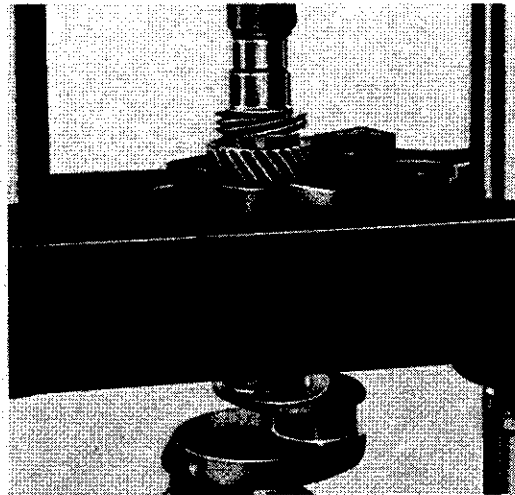


Fig. 2

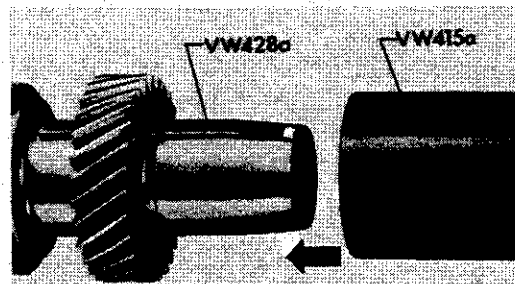


Fig. 3

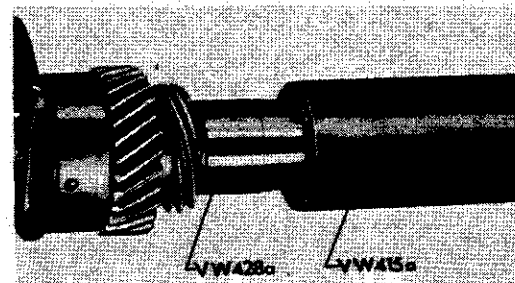


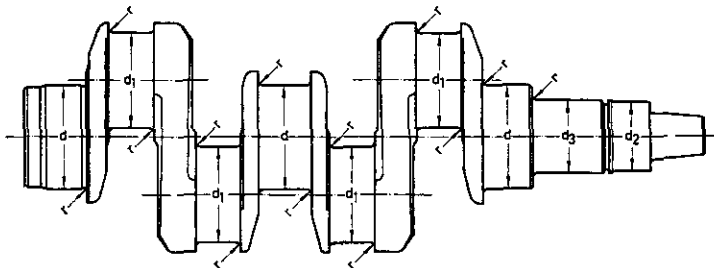
Fig. 4

Regrinding crankshaft

For reconditioning the following measurements should be obtained:

	Main journals Nos. 1, 2 and 3 (d)		Connecting rod journals (d ₁)		Main journal No. 4 (d ₂)	
	Nominal diameter	Lapped diameter	Nominal diameter	Lapped diameter	Nominal diameter	Lapped diameter
Standard	55.00 mm 2.1653 in.	54.990 mm 2.1648 in. 54.971 mm 2.1642 in.	55.00 mm 2.1653 in.	54.996 mm 2.1654 in. 54.983 mm 2.1653 in.	40.00 mm 1.5748 in.	40.00 mm 1.5748 in. 39.984 mm 1.5742 in.
1st Undersize	54.75 mm 2.1555 in.	54.740 mm 2.1551 in. 54.721 mm 2.1544 in.	54.75 mm 2.1555 in.	54.746 mm 2.1555 in. 54.733 mm 2.1550 in.	39.75 mm 1.5650 in.	39.750 mm 1.5650 in. 39.734 mm 1.5643 in.
2nd Undersize	54.50 mm 2.1457 in.	54.490 mm 2.1453 in. 54.471 mm 2.1445 in.	54.50 mm 2.1457 in.	54.496 mm 2.1459 in. 54.483 mm 2.1451 in.	39.50 mm 1.5550 in.	39.50 mm 1.5551 in. 39.484 mm 1.5545 in.
3rd Undersize	54.25 mm 2.1358 in.	54.240 mm 2.1353 in. 54.221 mm 2.1347 in.	54.25 mm 2.1358 in.	54.246 mm 2.1352 in. 54.233 mm 2.1347 in.	39.25 mm 1.5453 in.	39.250 mm 1.5452 in. 39.234 mm 1.5446 in.

Thorough grinding of the radii is of great importance to the life of the crankshaft. Try to get a radius of 2.5 mm. Repolish the radii.



On no account must the bearing shells be re-machined.

$$d_3 = \frac{42.006}{41.995} \text{ mm dia. } \frac{1.6538}{1.6533} \text{ in.}$$

After grinding, remove sharp edges on oil passages by slightly chamfering them.

$$r = \frac{2.5}{2.0} \text{ mm } \frac{0.10}{0.08} \text{ in.}$$

Crankshaft timing gear and distributor drive gear must be a press fit on the crankshaft

$$\frac{42.006 \text{ mm}}{41.995 \text{ mm}} \text{ dia. } \frac{1.6538 \text{ in.}}{1.6533 \text{ in.}}$$

Where the gears are worn from being removed and installed several times, the press fit can be restored by chromium plating or metal spraying.

To make sure the crankshaft is free from internal cracks, perform a "ringing test" prior to installation. The crankshaft must then be checked for run-out.

Checking

- 1 - Check connecting rods for external damage.

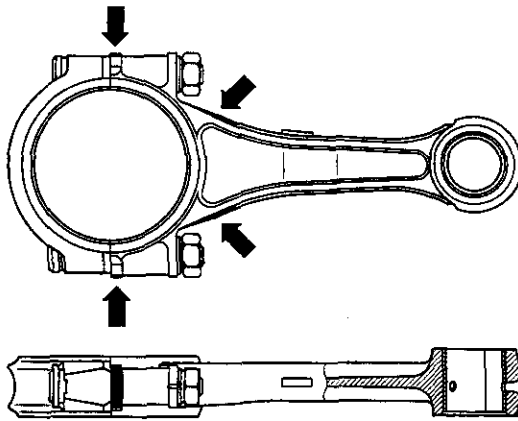
Note

Connecting rod bolts must be driven or pressed out. If connecting rod bolts are damaged, the complete connecting rod must be replaced.

- 2 - Check weight of connecting rods:

The difference in weight between the connecting rods in an engine must not exceed 10 grams. If one or more connecting rods are replaced, all of them must be re-weighed, as connecting rods in two weight ranges only are supplied as spare parts (see table).

If necessary, metal should be removed from the heavier connecting rods at the points indicated in the drawing. A reduction of approximately 8 grams in weight can thus be obtained.



Weight class
brown
in grams

580–588

Weight class
gray
in grams

592–600

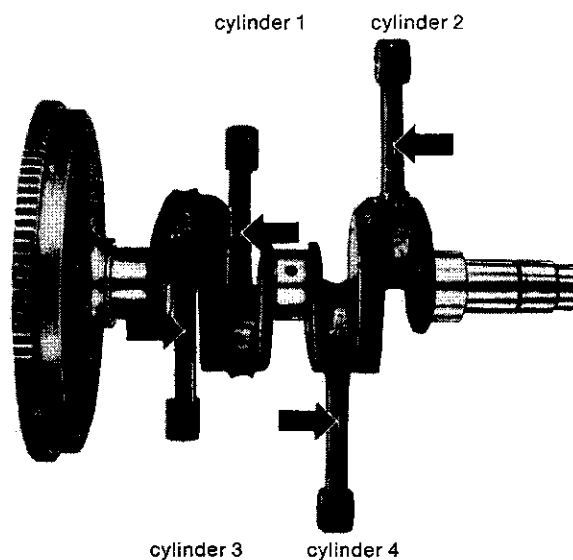
The connecting rod weight is the weight of a complete connecting rod without bearing shells.

- 3 - Check piston pin bushing. At room temperature the piston pin should be a push fit in a new bushing.
- 4 - Check connecting rod in appliance. If necessary, correct alignment.



Installing

- 1 - The figures near the joint of the connecting rod and cap must be on the same side.
- 2 - The forged mark on the connecting rod must be upward on installation (arrows).



- 3 - Slight pretension between the bearing halves, which can occur when tightening the connecting rod bolts, can be eliminated by light hammer taps on both sides of the connecting rod.

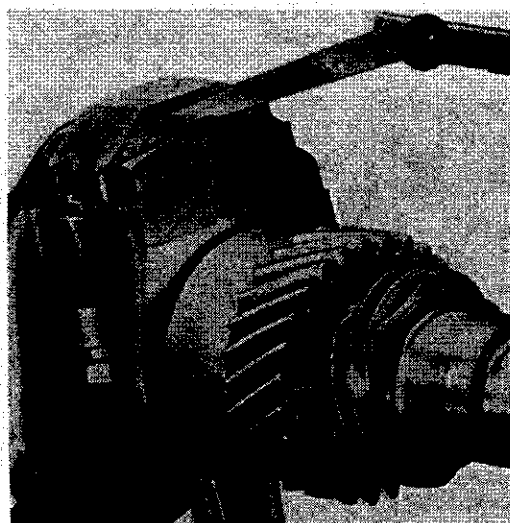
The connecting rod must fall smoothly under its own weight. On no account is it permissible to scrape, ream or file the bearings.



- 4 - Measure axial play of connecting rods with a feeler gauge.

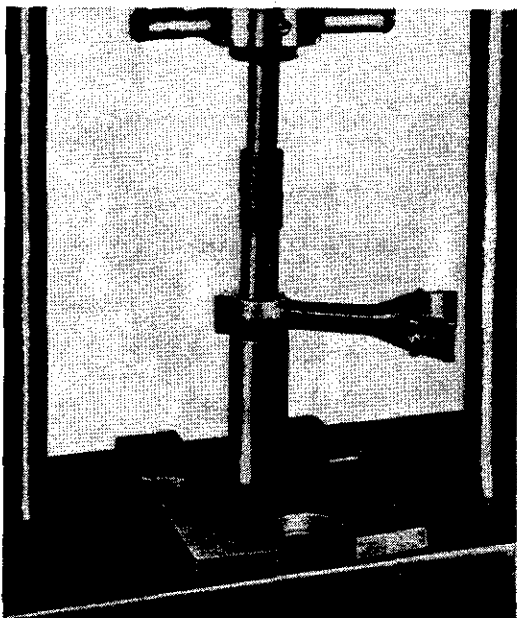
New: 0.1–0.4 mm (0.004–0.0016 in.)

Wear limit: 0.7 mm (0.028 in.)



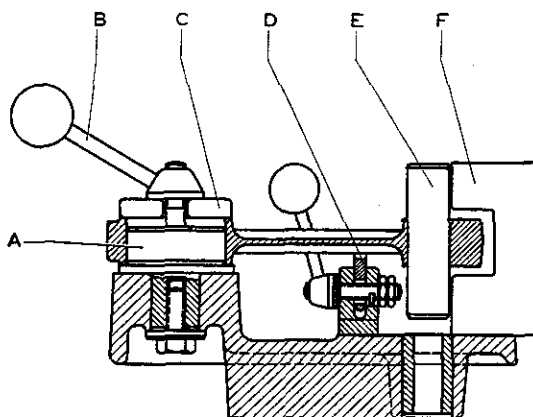
M

Type 1 Crankcase, Flywheel, Camshaft, Crankshaft and Connecting Rods



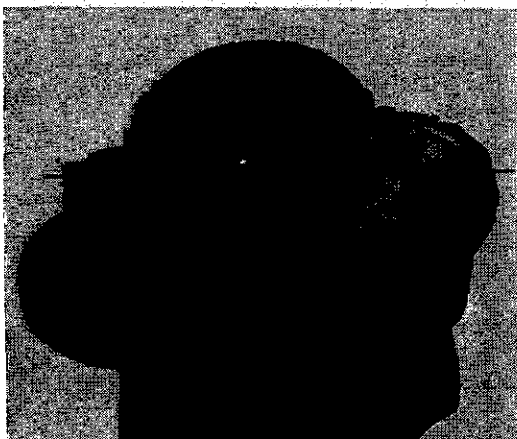
Connecting rods which are slightly bent can be straightened and the bushings can be replaced if worn.

- 1 - Press bushing out on press, using VW 402, VW 408 a and VW 416 b.



- | | |
|-------------------|-------------|
| A - Mandrel | D - Support |
| B - Locking lever | E - Pin |
| C - Washer | F - Gauge |

- 2 - Place mandrel (7 mm eccentric) in VW 214 f and attach connecting rod.

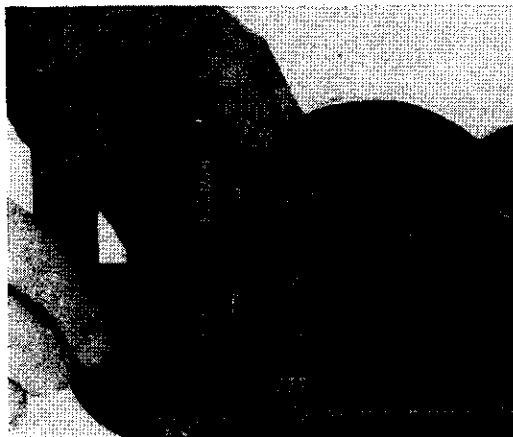


Turn mandrel "A" so that the flat is at right angles to center line of connecting rod.

- 3 - After inserting washer "C", tighten locking lever B until connecting rod can just be moved in both directions. Support "D" is not tightened.
- 4 - Insert pin "E" into connecting rod and push it toward mandrel "A" with two fingers so that there is no tilt between mandrel and big end of connecting rod or between connecting rod eye and pin.

- 5 - Check connecting rod for twist and parallelism with the gauge "F".

(The picture shows the parallelism check.)

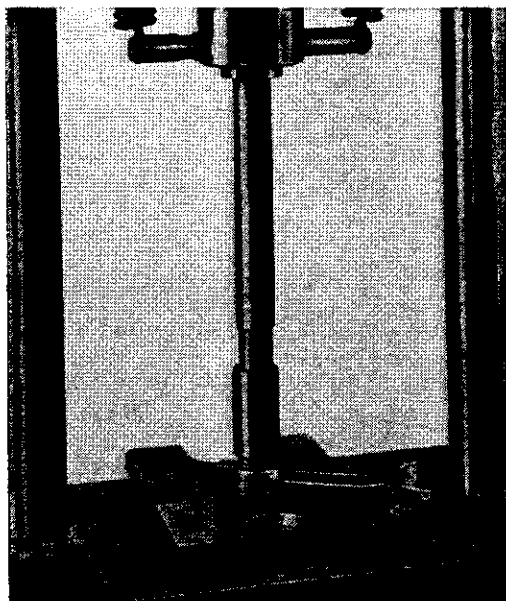


If deviations occur, tighten locking lever and straighten connecting rod with the bar.

- 6 - Press bushing in, using press tools given in chart.

- 7 - Drill oil holes (3.5 mm diameter).

- 8 - Insert reamer through connecting rod eye and corresponding hole in device. The conical bushing ensures correct centering of piston pin bushing.



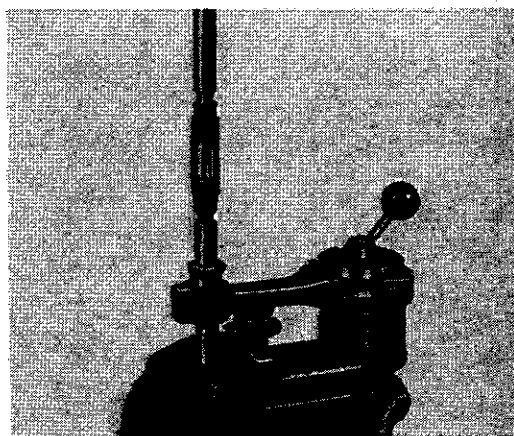
Tighten locking lever and support.

- 9 - Ream connecting rod bushing. Inside diameter:

22.009 to 22.017 mm (0.8664 to 0.8667 in.).

The bushing bore must be free from scores and chatter marks after reaming. Without applying oil, the piston pin must be a light push fit. It is not permissible to fit an oversize piston pin in order to eliminate excessive clearance between piston pin and bushing. A new bushing must, in all cases, be installed and reamed to size.

- 10 - Re-check connecting rod for parallelism and twist as mentioned previously, but this time with piston pin installed. Slight deviations can be corrected by inserting a bar into piston pin and straightening.





1



3



2

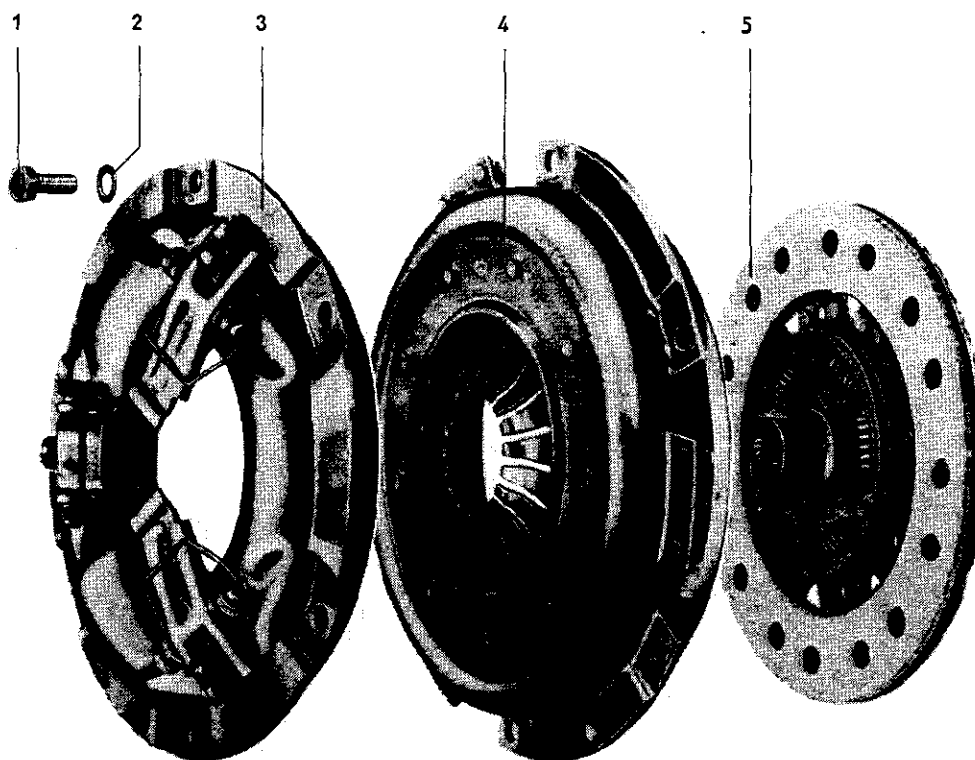


4

No.	Description	Special tool	Remarks
1	Straight edge		at least 200 mm long
2	Feeler gauge		
3	Drive shaft (part of)		
4	Flywheel retainer	VW 215 c	

M

Type 1 Clutch Pressure Plate, Clutch Disc, Clutch Control



No.	Description	Qty.	removing	Note when installing	Special instructions see
1	Bolt M 8×15	6	loosen diagonally	torque diagonally to 2.5 mkg (18 lb ft)	
2	Lock washer	6			
3	Disc spring clutch (up to July 1972, Chass. No. 1122961362)	1	mark position	(up to July 1970 with release ring) clean and check surface for wear	Fig. 1 Fig. 3
4	Diaphragm spring clutch (from Aug. 1972, Chass. No. 1132000011)	1	mark position	check tightness of rivets, clean and check surface for wear	Fig. 1 Fig. 3
5	Clutch disc	1		check for wear, check splines, plate must slide freely on the main shaft without excessive play check rivets and disc for run-out lubricate drive shaft splines with molybdenum disulfide powder	Fig. 2 Fig. 3

8.1 1-2 Removing and installing clutch

Removing

- 1 - New engines are balanced during factory assembly. To avoid imbalance after the engine has been reassembled, mark the position of the clutch on the flywheel (arrow).
- 2 - Loosen mounting bolts alternately and diagonally.

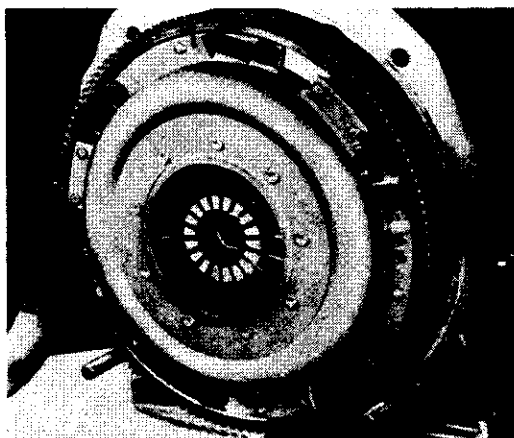
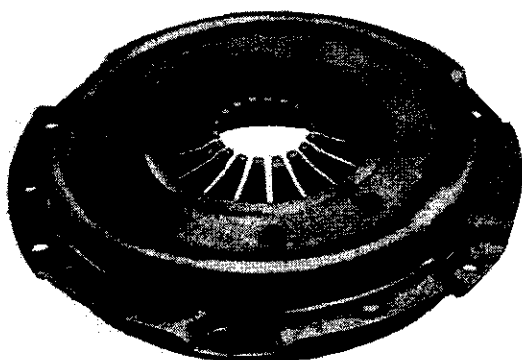
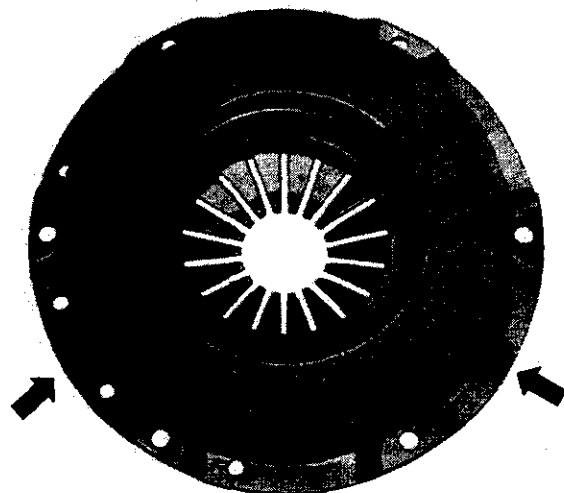


Fig. 1



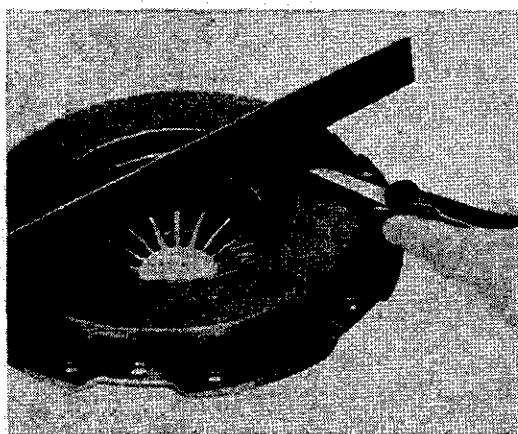
Checking

- 1 - Check ends of diaphragm spring (arrows) for scoring where the release bearing contacts. Scores up to a depth of 0.3 mm (0.012 in.) can be ignored.

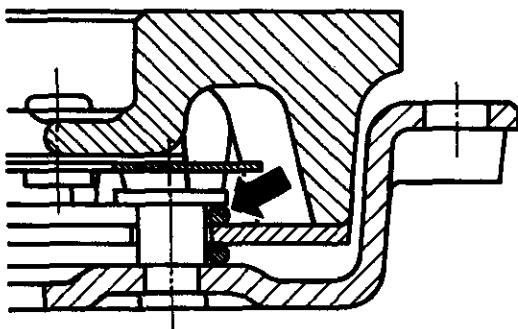


- 2 - Check straps between pressure plate and cover for cracks. Check tightness of rivets (arrows).

Clutch with damaged or loose rivets should be replaced.



- 3 - Check pressure plate friction surface for cracks, burn marks and wear. Pressure plates on which the friction surfaces have an inward taper of up to 0.3 mm (0.012 in.) can be used again.



- 4 - The diaphragm spring is riveted to the clutch cover and held between two wire rings.

If the rivet heads or rings show signs of wear, the clutch should be replaced.

Checking clutch disc

Maximum run out: 0.5 mm (0.02 in.) measured at 195 mm (7.677 in.) diameter.

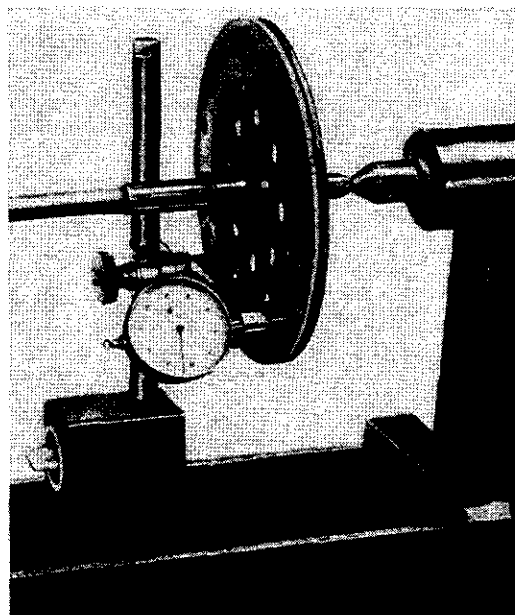


Fig. 2

Installing

- 1 - The needle bearing in the gland nut should only be lubricated after it has been washed in solvent. Use about 0.2 cm³ of multi-purpose grease. Apply oil to felt ring. Wipe off excess lubricants.

- 2 - Check clutch and clutch driven plate. Instructions on this are given in the sections "Clutch Checking" and "Clutch Driven Plate".

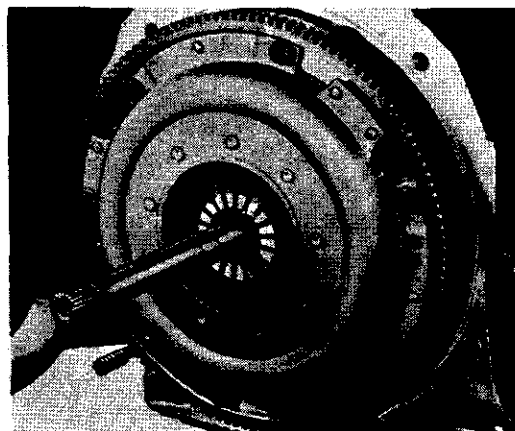
- 3 - Check drive shaft splines and lubricate sliding surfaces with molybdenum disulfide powder. The powder should be applied lightly with a brush or cloth.

The driven plate must slide freely on the splines without excessive clearance.

- 4 - Clean the release bearing by wiping with a clean cloth. Replace noisy and oily bearings. Make sure retaining springs are correctly positioned.

Grease guide bushing lightly with molybdenum disulfide paste (only on centrally located release bearing).

- 5 - Insert clutch plate into flywheel.
A shortened main drive shaft can be used to center the driven plate.
- 6 - Install clutch with marks aligned. New parts without marks can be installed in any position.
- 7 - Tighten bolts uniformly and diagonally to 2.5 mkg (18 lb ft).

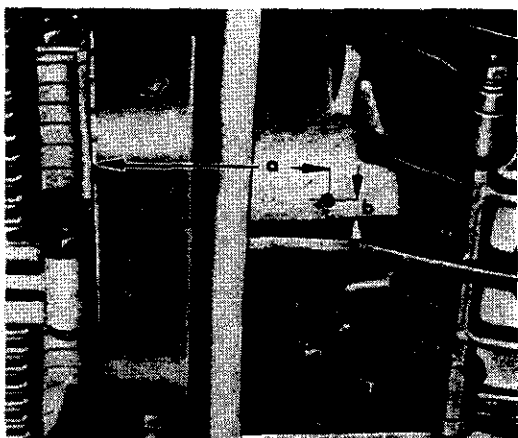


Installing

- 1 - Check release bearing. The ball bearing is maintenance-free. On no account must the bearing be washed with benzine or other cleaning fluids. Merely use a clean cloth to clean it. Replace internally noisy bearings.
- 2 - Roughen plastic ring with coarse emery cloth and apply molybdenum disulfide paste sparingly.
- 3 - Lightly coat the pivoting points between release bearing and operating shaft with multipurpose grease.
- 4 - Install retaining springs.
- 5 - Note that retaining springs are positioned correctly.
- 6 - Check clutch pedal free-play after the engine has been installed. Re-adjust if necessary.

Lubricating plastic ring

Slight oscillation between the plastic ring on the release bearing and the clutch release ring can, under certain conditions, cause a whistling noise. The noise is harmless and does not affect the service life or the operation of the release bearing. Experience has shown that in such cases, lubricating the plastic ring with molybdenum disulfide based paste will stop the noise. Replacement of the bearing because of the noise described above is not justified.

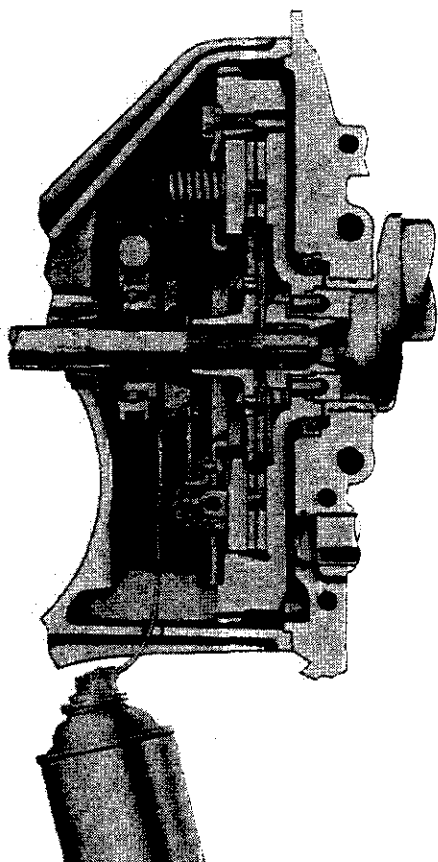


- 1 - Lift vehicle and drill a 10 mm ($\frac{23}{32}$ in.) hole in the transmission case at the point shown in illustration.

"a" = 67 mm ($2\frac{5}{8}$ in.)

"b" = 10 mm ($\frac{23}{32}$ in.)

- 2 - Increase the space between release bearing and release ring by unscrewing the adjusting nut on the clutch cable about 5 turns.



- 3 - Spray plastic ring on release bearing and release ring with a molybdenum disulfide based lubricant.

Spraying time — max. 2 seconds.

Note

Use only a spray compound with a molybdenum disulfide base which contains no oil or grease.

Use an extension for the spray can 140 mm (5.5 in.).

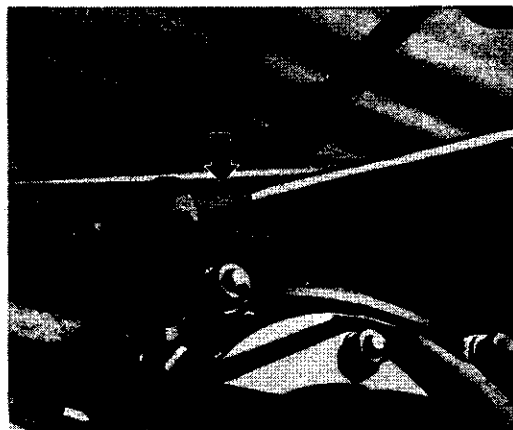
- 4 - Close the hole with rubber buffer, Part No. 211 843 749.

- 5 - Adjust clutch free play.

Removing

- 1 - Disconnect clutch cable from clutch operating lever.
- 2 - Withdraw rubber sleeve from guide tube and cable (arrow).

Remove pedal cluster (see B 2.7/1).

**Installing**

- 1 - Check threaded part of clutch cable for freeness and grease clutch cable with multipurpose grease.
- 2 - Insert clutch cable as shown in illustration.
- 3 - Grease clutch cable eye and clutch pedal shaft with multipurpose grease.
- 4 - Note correct position of the rubber sleeve at the end of the guide tube.
- 5 - Adjust clutch play.
- 6 - Grease wing nut for clutch cable with multipurpose grease.

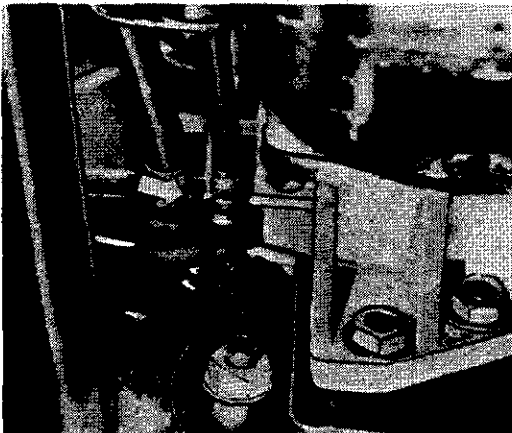
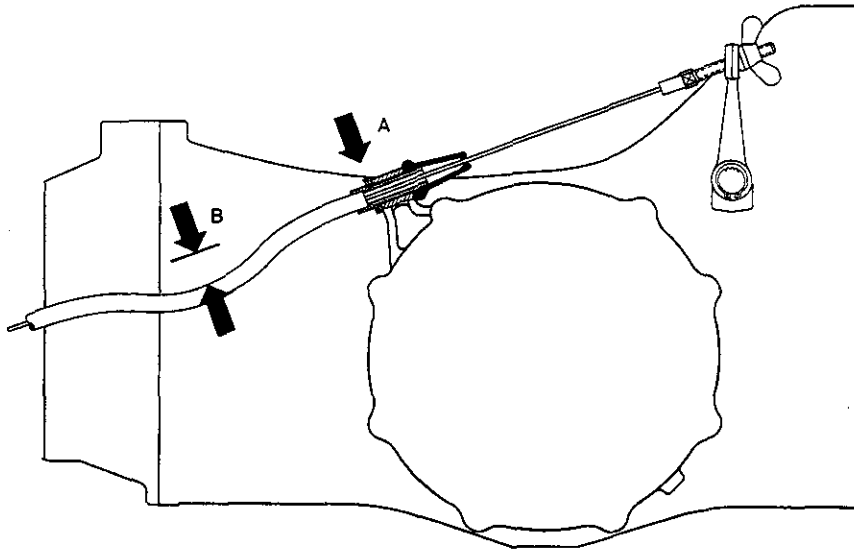
Install pedal cluster (see B 2.7/1).



Note

The clutch cable guide tube should sag 25–45 mm (1–1²⁵/₃₂ in.) (B). This preload is obtained by inserting washers between the bracket on the transmission and the end piece of the guide tube (A).

If the cable guide tube is bent down too much it will make the cable stiff in operation and can create noises or cause breakage of the cable. This trouble can be remedied by shortening the guide tube at the rear end after removing tube and cable.



The guide for the clutch cable has been provided with a hole (arrow) to lubricate the clutch cable.

If the clutch cable creaks, jams or is stiff in operation, it should be lubricated carefully via the lubrication hole.

Use a manual lever-type grease gun with the nozzle as used for the Type 1 door hinges.

After lubricating reinstall the sealing boot for the cable guide.

Clutch cable

From October 1971, Chassis No. 112 2205 116, the clutch linkage has been altered (see Workshop Manual H). In addition, the bow of the clutch cable has been increased to approximately 70 mm ($2\frac{3}{4}$ in.).

If the clutch cable is broken on a vehicle produced after this Chassis No. the following parts are to be used for the repair:

Clutch cable — Part No. 113 721 335 A
total length 2260 mm ($89\frac{31}{32}$ in.)

Clutch cable sleeve — Part No. 311 721 361
total length 330 mm (13 in.)

Washer — Part No. N 11 531.4

When installing these parts the bend in the clutch cable sleeve is reduced to 25–45 mm ($1\text{--}1\frac{25}{32}$ in.).

Note

The cable must be well greased before it is installed. Push the washer onto the rear end of the cable sleeve. Install the sleeve together with the rubber seal in the bracket on the transmission first. Ensure that it is installed properly on the guide tube.

Turn the lubricating hole downward and make sure that the sealing rubber is sitting correctly. Adjust the clutch pedal free play and coat the threaded end with grease.

Clutch play:

Between clutch lever and wing nut = 1–2 mm ($\frac{1}{32}$ – $\frac{3}{32}$ in.). Pedal free-play (a) = 10–20 mm ($\frac{13}{32}$ – $\frac{13}{16}$ in.).

As the clutch linings wear, the clearance between release bearing and release ring is reduced. If there is no play, the clutch pressure is reduced which can lead to clutch slippage and the linings becoming burnt.

Adjusting

- 1 - Adjust the clutch by turning the wing nut (arrow) until the pedal free-play is

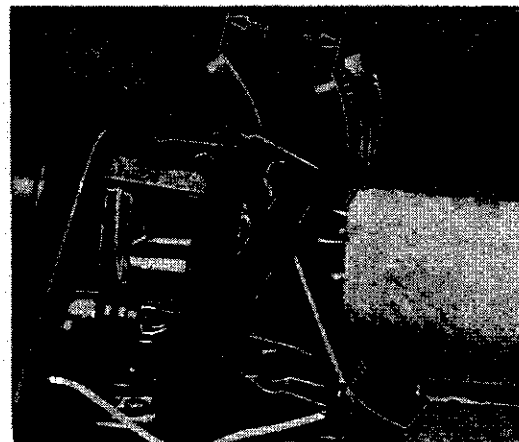
"a" = 10–20 mm ($\frac{13}{32}$ – $\frac{13}{16}$ in.)

When the free-play is correct, there will be clearance of about 2 mm ($\frac{3}{32}$ in.) between clutch lever and wing nut.

- 2 - After adjusting, make sure that the two lugs of the wing nut engage into the cutouts in the clutch lever.

- 3 - Depress clutch pedal several times and check play again.

- 4 - Lubricate threads of clutch cable, wing nut and countersunk hole in clutch lever with multipurpose grease.



Adjusting clutch play

Types 1, 2, 3

The clutch is to be adjusted so that there is a clearance of .04—.08 in. (1—2 mm) between the release bearing and the release ring with the clutch engaged. Measured at the clutch pedal, the free-play is between .4 and .8 in. (10 and 20 mm). The free-play is adjusted with the wing nut on the clutch operating lever.

As the clutch linings wear, the clearance between release bearing and release ring is reduced. If there is no play at all, the clutch pressure is reduced which can lead to clutch slippage and the linings becoming burnt.

Adjusting

- 1 - Grip the clutch cable tightly with combination pliers and adjust the clutch by turning the wing nut until the pedal free-play is

$$a = .4\text{—}.8 \text{ in. (10—20 mm)}$$

There will be clearance of about .08 in. (2 mm) between clutch lever and wing nut.

- 2 - After adjusting, ensure that the two lugs of the wing nut engage into the cutouts in the clutch lever.
- 3 - Depress clutch pedal several times and check play again.
- 4 - Lubricate threads of clutch cable, wing nut and countersunk hole in clutch lever with multipurpose grease.



Repairing tapped holes

Damaged or broken threads, on cylinder head for example, can be made reserviceable by installing appropriate HELI-COIL thread inserts.

Sequence of operations

- 1 - Enlarge damaged tapped hole to nominal diameter.
- 2 - Cut new thread with appropriate HELI-COIL tap and clean.

HELI-COIL assortment for Volkswagen.

Thread sizes: M 6×1 (VW interference fit)

M 7×1

M 8×1.25 (VW interference fit)

M 10×1.5 (VW interference fit)

M 10×1.5

M 12×1.5

M 14×1.25

M 14×1.5

- 3 - Place insert into chamber of installing tool.

Caution

The tang of the insert must be at the bottom, as it engages the slot in the installing tool. As soon as the tang engages the slot in the tool, turn tool slowly until the insert is turned by the tensioning sleeve. Then place installing tool over newly tapped hole, screw thread insert in to required depth and withdraw installing tool. The insert should be $\frac{1}{4}$ to $1\frac{1}{2}$ threads below the surface.

- 4 - Break tang off thread insert with suitable pliers.

When cylinder head studs are loose or have pulled out of the crankcase it is advisable to install threaded steel inserts (available under Part. No. ZVP 107 101).

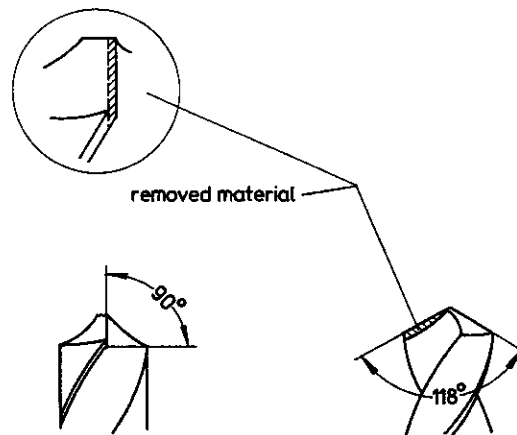
These inserts have a locking feature on the outside diameter for the crankcase material as well as on the inside diameter for the crankcase stud. Oil leakage is prevented by using closed end inserts for the open stud holes.

A special tool set (US 4415) has been developed to provide the proper interference fit between crankcase and insert.

- 1 - Place drill and tap jig in cylinder bore. Align the small hole with pilot into the stud hole and lock jig with wingnut.
- 2 - Drill through ($\frac{33}{64}$ " diameter) on open holes, respectively drill blind holes to the depth of former thread. (To assure effective cutting into the magnesium crankcase and to avoid "sudden grabbing", the drill has to be dressed on the cutting lips to 90° , per sketch.)
- 3 - Repeat the same operation on the 3 remaining holes per cylinder.
- 4 - Line up drill and tap jig with large diameter of pilot, lock with wingnut for tapping operation.
- 5 - Cut $\frac{9}{16}$ " thread (modified) with special tap by hand or with a $\frac{3}{8}$ " reversible impact wrench.
- 6 - Remove drill jig and install the appropriate insert with insert tool US 4415-6.

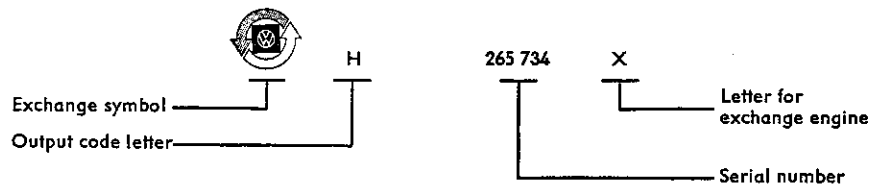
The correct installation depth is achieved when the distance between tool and cylinder sealing surface is 1 mm, i.e. when the upper surface of the insert is slightly below the surface of the cylinder seat.

- 7 - Lock insert with insert tool by driving the 4 "Kee's" into the crankcase material with hammer.



VW exchange engines are stamped with the exchange symbol and an exchange number. The exchange number consists of an output code number, a serial number and the letter X for exchange engine. Before October 1968 the letter X was not stamped on exchange engines.

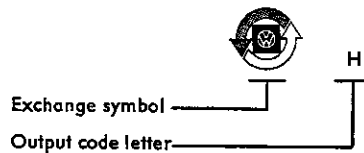
e. g. for VW exchange engines



VW exchange short block engines.

From April 1972 short block engines are only stamped with the exchange symbol and an output code letter. When a short block engine is installed, the number of the old engine must be transferred to the new engine.

e. g. for VW exchange short block engines

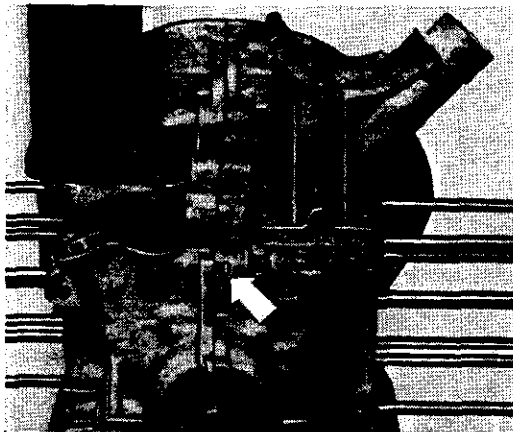


Special instructions for short block engines

New and exchange short block engines are protected against corrosion inside and out.

The outside of the engine is sprayed with a wax-based compound. In order to avoid odors and clutch trouble, the engines should be washed with a cold cleaning solution or a depreserving agent before being built up for installation. Seal all openings in crankcase and cylinder heads before washing. All cleaning agent that does not drip off should be blown off with compressed air. Afterward the needle bearing and felt ring in the gland nut must be greased again properly.

The inside treatment is done with anti-corrosion oil that is drained off after use. The residue of about 100 cc that is left in the engine, mixes with the initial filling of engine oil.



Repair instructions

An exchange engine can differ from a new engine. Because of reworking of various components during reconditioning a number of parts are oversize or undersize.

Note the following when repairing an exchange engine.

1 - Crankcase

- a - Crankcases on which the joining surfaces have been reworked or the crankshaft bearing seats bored out are marked on the right case half (arrow).

P - Planed (standard dimensions)

O - Crankshaft bores oversize

Caution

Engines marked with an "O" have an oversize crankshaft pulley or fan wheels. Oversize crankshaft pulleys are marked with two circumferential grooves and oversize fan wheels with two 4 mm (0.157 in.) diameter countersink marks on the front.

- b - When the cylinder seats on the crankcase have been reworked 0.8 mm (0.031 in.) spacer rings are installed between crankcase and cylinder gaskets.

These rings **must not** be left out because this would alter the compression.

2 - Crankshaft

Crankshafts with worn journals are ground down as follows:

	Main journals 1, 2, 3 and crankpins diameter mm (in.)	Main journal 4 diameter mm (in.)
1st undersize	54.75 (2.1555)	39.75 (1.5650)
2nd undersize	54.50 (2.1457)	39.50 (1.5551)
3rd undersize	54.25 (2.1358)	39.25 (1.5453)
4th undersize	54.00 (2.1259)	39.00 (1.5354)

The following table shows which crankshaft bearings are to be installed with reground shafts and bored out crankcases.

Standard

Crankcase bores	Bearings 1, 2 and 3 = 65 mm (2.5590 in.) Bearing 4 = 50 mm (1.9685 in.)			
Crankshaft	1st undersize mm (in.)	2nd undersize mm (in.)	3rd undersize mm (in.)	4th undersize mm (in.)
Bearings 1, 2 and 3 and crankpins	54.75 (2.1555)	54.50 (2.1457)	54.25 (2.1358)	54.00 (2.1259)
Bearing 4	39.75 (1.5650)	39.50 (1.5551)	39.25 (1.5453)	39.00 (1.5354)

	Spare part No.			
SP Set	111 198 463	111 198 465	111 198 467	111 198 469
consisting of:				
Crankshaft				
bearings 1	113 105 507 A	113 105 513 A	113 105 519 A	113 105 525 A
2	131 105 537	131 105 543	131 105 549	131 105 555
3	113 105 567	113 105 573	113 105 579	113 105 585
4	021 105 597	021 105 603	021 105 609	113 105 615
Connecting rod				
bearings	113 105 707	113 105 713	113 105 719	113 105 725

Oversize

Crankcase bores	Bearings 1, 2 and 3 = 65.50 mm (2.5786 in.) Bearing 4 = 50.50 mm (1.9881 in.)		
Crankshaft Bearings 1, 2, 3 and crankpins	Standard/mm (in.)	1st undersize/mm (in.)	2nd undersize/mm (in.)
Bearing 4	55.00 (2.1653) 40.00 (1.5748)	54.75 (2.1555) 39.75 (1.5650)	54.50 (2.1457) 39.50 (1.5550)

Spare part No.			
SP Set	111 198 471	111 198 473	—
consisting of:			
Crankshaft bearings 1	113 105 503 D	113 105 509 D	113 105 515 A
2	131 105 533	131 105 539	113 105 545
3	113 105 563	113 105 569	113 105 575
4	113 105 593 A	113 105 599 A	113 105 605
Connecting rod bearings	113 105 701	113 105 707	113 105 713

Crankshaft bearing 1 (with thicker thrust shoulder)	113 105 503 A	113 105 509 A	—
---	---------------	---------------	---

Caution

Up to January 1973 the crankshaft and connecting rod bearings had always been the same undersizes. From January 1973 the crankshaft and connecting rod bearing undersizes could differ.
e. g. crankshaft bearings = 1st undersize and the connecting rod bearings = 2nd undersize.

3 - Camshaft

- a - Worn camshaft bearing journals are reground to an undersize of 24.75 mm (0.9744 in.).
- b - The camshaft bores in the crankcase are bored out to 28.00 mm (1.1023 in.) if necessary.

The following camshaft bearing shells are used.

Crankcase bores	Standard 27.5 mm (1.0826 in.) (undersize)	(oversize) 28.00 mm (1.1023 in.) (Standard)
Camshaft journals	24.75 mm (0.9744 in.)	25.00 mm (0.9842 in.)

Spare part No.		
SP Set	111 198 543	111 198 542
consisting of:		
Camshaft bearings 1	113 101 503	113 101 507
2	113 101 513	113 101 517
3 left	113 101 523 A	113 101 527
3 right	113 101 524	113 101 528

4 - Oil pressure valves

The bores in the crankcase for the oil pressure control and pressure relief valves are bored out where necessary and oversize plungers installed.

Standard plunger, diameter = 16.0 mm (0.6299 in.)

Oversize plunger, diameter = 16.5 mm (0.6496 in.)

5 - Cylinder head

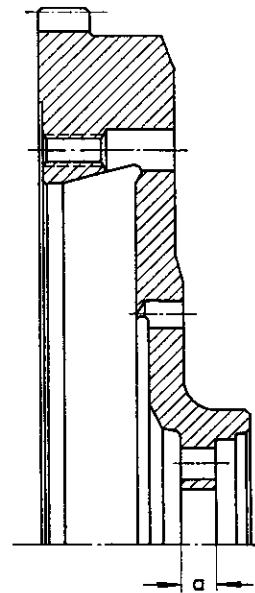
When the cylinder seats in the head have been reworked, a 1 mm (0.0393 in.) thick spacer ring is fitted between cylinder and head with effect from October 1971.

Older engines may have 0.8 mm (0.0314 in.) and 1.5 mm (0.0590 in.) thick spacer rings.

If the rings have to be replaced during a repair, watch the ring thickness as otherwise the compression will be altered.

6 - Gland nut — Flywheel

The various flywheel reworking operations include the machining of the crankshaft seating which reduces the thickness of the flange "a". When installing such flywheels, note the length of the dowels and gland nut.



The following dowels and gland nuts are used with reworked flywheels:

Flywheel flange thickness "a" mm (in.)	Dowel mm (in.)	Shim mm (in.)	Gland nut shaft — length mm (in.)
6.2—6.7 (0.244—0.263)	111 105 277 A 12.5 (0.492)	—	111 105 305 DX*) 24 (0.944)
6.2—6.7 (0.244—0.263)	111 105 277 A 12.5 (0.492)	111 105 297 A 1.4 (0.055)	111 105 305 D 25 (0.984)
6.7—7.2 (0.263—0.283)	113 105 277 14.0 (0.551)	—	111 105 305 D 25 (0.984)
7.2—8.0 (0.283—0.314)	113 105 277 14.0 (0.551)	—	111 105 305 E 27 (1.062)

*) This gland nut is not available as a spare part. Use gland nut with 25 mm (0.984 in.) long threaded portion and shim 111 105 297 A.